NATURE

No. 4190 SATURDAY, FEBRUARY 18, 1950 Vol. 165

CONTENTS

	Page
Co-operation in Colonial Development	251
Jan Swammerdam (1637-80). By Prof. F. J. Cole, F.R.S.	254
Introduction to Anthropology. By Prof. J. H. Hutton, C.I.E.	255
Modern Science for the Layman. By W. L. Sumner	255
The Science of Human Society. By Prof. T. S. Simey	256
Jubilee of the National Physical Laboratory, Teddington	257
Seventh International Congress for Applied Mechanics, 1948. By Sir Geoffrey Taylor, F.R.S.	258
Commonwealth Contributions to the British Diet	260
News and Views	262
Inactivation of Ribonuclease in Dilute Aqueous Solutions. By Dr. B. Holmes; E. Collinson, Dr. F. S. Dainton and Dr. B. Holmes	266
Non-Localizable Fields and Reciprocity. By Prof. M. Born, F.R.S.	269
Sixth (U.S.S.R.) Congress on High-Molecular Compounds. By G. W. S. B.	270
Independence of Fundamental Research	270
The Mathematical Association: Annual Meeting	271
Letters to the Editors:	
An Electron-Microscopic Investigation of the Cell-wall Organisation of Conifer Tracheids.—A. J. Hodge and Dr. A. B. Wardrop	272
A Simple Replica Technique Suitable for the Study of Surface Structures.—D. J. Crisp and Dr. W. H. Thorpe	273
Mass Measurements on Fast Particles Ejected from Cosmic Ray Stars.—J. B. Harding	273
Antibiotics from *Aspergillus melleus*.—H. S. Burton	274
Epicuticle of Blow-fly Larvæ.—Prof. R. Dennell	275
Quinone Tanning in the Animal Kingdom.—C. H. Brown	275
Inhibition of Human Serum Cholinesterase by some 4-Hydroxycoumarin Derivatives.—V. Grossmann, I. M. Hais and B. Kasalicky	276
Demonstration of Incomplete *Rh*-Antibodies by Alpha-Globulin.—Dr. E. A. McCulloch	276
Glycogen Production from Glucose with Desoxycorticosterone and 11-Dehydro-17-hydroxycorticosterone.—Dr. F. C. Wang	277
Electrophoretic Heterogeneity of Crystallized Pepsin.—H. Hoch	278
Hepatic and Splenic Sympathin.—Monica Mann and Dr. G. B. West	279
Secretion of Red Blood Corpuscles as Seen in the Camel.—Dr. Frederic Duran-Jorda	279
Relation between Vitamin B_{12} and the Red Blood Cells.—Dr. C. Ockrent	280
Minimum and Maximum Limits of Photon-Energy.—G. J. Whitrow	281
Schumann–Runge Absorption Bands in Heated Oxygen.—W. R. S. Garton and M. W. Feast	281
Sensitivity of Ants to Polarized Light.—D. M. Vowles	282
Ciliary Feeding Mechanisms in Anuran Larvæ.—J. M. Dodd	283
Fate of the Neural Crest in Lampreys.—D. R. Newth	284
Function and Operation of the Facial Pit of the Pit Vipers.—Myron J. Block	284
A Dispersion of Mosquitoes by Wind.—Dr. C. Garrett-Jones	285
Œdema of the Bowel in Pigs.—D. Luke and W. A. M. Gordon	286
Geographical Distribution of the Body-Weight/Body-Surface Ratio.—Eugène Schreider	286

Editorial and Publishing Offices of "NATURE"
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831
Telegrams: Phusis Lesquare London
Advertisements only should be addressed to
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942
The annual subscription rate is £4 10 0, payable in advance, inland or Abroad

All rights reserved. Registered as a Newspaper at the General Post Office

CO-OPERATION IN COLONIAL DEVELOPMENT

As has already been noted in *Nature*, the Parliamentary and Scientific Committee has been closely considering the implications of President Truman's 'fourth point' regarding technical assistance to the backward areas since it was first made known in his inaugural address in January 1949. Following the circulation of all available information, a sub-committee was appointed, and the interim report of this committee (see *Nature*, **164**, 463; 1949) was sent to appropriate Ministers on July 29, 1949. Afterwards, Mr. M. P. Price, chairman of the Parliamentary and Scientific Committee, attended the World Resources Conference at Lake Success; and at a meeting of the Committee on November 8, Mr. Price, and also Dr. W. F. P. McLintock, director of the Geological Survey and Museum, Mr. Michael Graham, director of fishery research, and Prof. W. N. Woodward, director of the Scottish Seaweed Research Association, all of whom had attended the Conference, spoke of the work of the Conference particularly with a view to possible further useful action by the Committee.

In Dr. McLintock's view, Great Britain is fulfilling its obligations to the under-developed countries to the limit of its man-power; and confirmation of this can well be found in the statement recently published by the Colonial Office. The recruitment of more than fourteen hundred highly qualified men and women last year for the Colonial Service represents no mean tax on the trained man-power of the country. It approaches ten per cent of the present annual output of university graduates, and with 1,130 vacancies still to be filled, three-quarters of which are in East, West and Central Africa, the situation cannot be viewed with any complacency. Moreover, quite apart from the Colonial Service—and the situation revealed by the last report on Colonial research, to which special attention has already been directed in these columns (*Nature*, **164**, 461; 1949)—the recent report of the Overseas Food Corporation and the African Regional Scientific Conference at Johannesburg (cf. *Nature*, **164**, 901; 1949) have stressed the great need for scientific workers to assist in dealing with African problems. The recent announcement that a technical survey of the Volta River, the largest in the Gold Coast, with a view to the development of its resources for irrigation, navigation and hydro-electric power, is being made at the request of the Gold Coast Government, by a panel of five engineers from a private firm of consulting engineers, shows that other reserves of scientific and technical skill are already being called upon to make good the deficit of government officers which, as the Johannesburg Conference indicated, is felt acutely in every territory and almost every field of science. Moreover, while the second report of the Inter-University Council for Higher Education in the Colonies shows that the Colonial universities are making real progress towards meeting such needs—the Faculty of Rural Sciences established at University College, Ibadan, to give teaching

in agriculture, veterinary science and, later, forestry deserves particular mention—it is clear from the same report that for some years to come they will draw heavily on the universities of Great Britain.

One of the most impressive features both of the World Resources Conference and of the African Regional Scientific Conference was the clear recognition of the need for co-operation across regional boundaries, and across the divisions of science itself. Sir Harold Hartley, leader of the British delegation at Lake Success, in his summing-up speech on the final day, stressed the need for a synthesis of specialists, so that water-power, irrigation, soil fertility, animal and plant husbandry could be developed together in a balanced system. In recommending the establishment in a consultative and advisory capacity of a scientific council for Africa south of the Sahara, the Johannesburg Conference also gave expression to its recognition of the need for pooling our knowledge and organising a broader collaborative approach not only to research problems but also to scientific and technical matters generally.

The Parliamentary and Scientific Committee has from the first considered President Truman's 'fourth point' primarily to ascertain how British resources in science and technology could collaborate most fully, and also how American technology and capital could further the plans we have already formulated for improving the conditions of the under-developed areas in British Colonial territory. It is encouraging to note that the panel of engineers surveying the Volta River has been instructed to take full account of the best methods for the economic development of the resources available, including not only hydro-electric power but also the irrigation and drainage of lands in or near the catchment area, the provision of port facilities, the possible improvement of transport by developing a system of navigation on the lake which would be formed by the proposed dam or by any other means. The distribution of the power between aluminium production and other industries and the towns, and the effect of development on native systems of land tenure and water rights, are also to be the subject of examination and recommendation.

Clearly the scarcity of properly trained scientific observers puts a limit to such surveys, fundamentally because their work is the necessary basis for sound planning. Even on the smaller scale, such matters as the re-settlement and improvement of African lands may be hindered by the lack of trained staff, as much as by lack of agricultural machinery. These are the chief factors that have hampered the Government of Kenya, for example, in its schemes for enlisting African co-operation not only in re-settlement but also in the restoration of fertility to the soil and the improvement of cultivation. More than £300,000 has been spent for this purpose since 1946, and between fifty and sixty projects are in progress or envisaged under the Kenya Development Plan.

The solid achievements of the Kenya Government in this field are now having their effect in making it easier to secure the co-operation of the Africans themselves, and the importance of this further limiting factor on the rate of progress needs to be kept in mind. Dr. Alexander King, in addressing the Parliamentary and Scientific Committee, referred to the great danger of forcing rapid developments without sufficient understanding of conditions and human resources. In his view, one of the most valuable features of the World Resources Conference was the way in which the general recognition that the future of the backward areas really depends on a co-ordinated policy of land conservation, water conservation, mineral development, agriculture and even education, has left on the minds not merely of those from the under-developed areas, but also of other countries, such as the United States, a salutary impression of the complexity of the whole question of development. Moreover, on the political level, Dr. King thought that the high quality of the United Kingdom representatives had given a most convincing demonstration of the immense amount of scientific experience which Great Britain has already gained in this field.

The importance of any such demonstration at the present time is not easily exaggerated. Even in the United States, ignorance of British achievements in the Colonial field is still widespread, and failure to understand the difference between the Colonial territories and the Dominions is common. Although such technical conferences as those at Lake Success and Johannesburg can only go a limited way in dispelling such misconceptions and misunderstandings, they at least provide a firm basis for the wider effort at popular education which is an essential condition for the mutual understanding and appreciation on which co-operative effort to assist the peoples of the under-developed areas must be based.

Nor is it only the British Colonial effort that is often not understood or even misrepresented; it is equally true of the French, the Dutch and the Belgian efforts. Little is popularly known, for example, of the important Belgian plans for developing the Congo during the next ten years, or of what has already been done in that area, which is still in an early stage of its development. Development of the Congo region is conditioned partly by the character of the country and partly by the distribution of the mineral resources; but through the area runs the strategic traffic artery which links the Atlantic with the upper waters of the Nile, and the first main motor highway between the Mediterranean and the Cape. So Belgium can with equanimity allow Congo communications to be integrated with the trans-African traffic routes.

Communications, electricity and agricultural development account for most of the estimated £285,000,000 of the ten-year plan; but even if Belgium is able to find the funds and requires no assistance under the United Nations plan for technical assistance to backward areas, the importance of international goodwill and understanding for the realization of its full effects needs scarcely to be stressed. That, however, is exactly what is endangered by recent proceedings under the Trusteeship Council and the Assembly of the United Nations. Lord Tweedsmuir spoke well and forcefully on this point in the debate on Colonial administration in the House of Lords on November 30 in deploring the failure of the

Trusteeship Council to move with us from the fatherly conception of trusteeship to the more brotherly conception of partnership. Lord Listowel, replying for the Government during the debate, made it very clear, as Lord Tweedsmuir wished, that, while advice or constructive criticism would be welcomed, Great Britain continues to accept full responsibility to the Colonial peoples.

Lord Listowel dealt in particular with the Trusteeship Council's decision to ask the Assembly to request Colonial Powers to add, to the subjects about which it has already been agreed to give information, the political and constitutional development of their Colonies, and to appoint a committee which will sit for three years, with powers of roving inquiry into social conditions and educational practice in Colonial territories. Lord Listowel rightly insisted that what mattered is the spirit in which the criticism is made and the motives of the critics themselves. Further, the criticism received from the United Nations, he said, is often characterized by an absence of realism and a failure to put forward practical suggestions, which results naturally from the inexperience of non-administering Powers, quite apart from the constant failure to distinguish between supervision of trust territories and interference in administration all along the line.

Lord Tweedsmuir made an interesting point when he observed that the Colonial territories had self-government before Great Britain went there; but what they are now asking for is a peculiarly British invention, namely, responsible government. The prerequisite of responsible government is the availability of men and women capable of discharging the duties involved. The full reply to the Trusteeship Council is, of course, an even more energetic attack on the problem of education, both in the backward areas and also in the world at large, so as to create an informed world opinion on Colonial affairs and on the position and possibilities in the backward areas.

Such an informed world opinion is, in fact, no less desirable in regard to the United Nations Organisation's own plans for technical assistance for economic development of the backward areas. These plans involve the expenditure of 35·9 million dollars in the first year and 50·2 million dollars in the second year on expert missions to the undeveloped countries, training students, financing scientific and industrial research, supplying seed, medical and technical equipment and in other ways spreading a knowledge of modern technique throughout these areas. These plans are at present tentative and tenuous, as well as extremely varied, and considerable possibilities of duplication exist, especially in the absence of any generally agreed definition of economic development or method for developing areas. Moreover, for reasons explained by the Secretary-General in issuing the United Nations plan for Technical Assistance for Economic Development last April, it is not possible to prepare a combined budget covering both the United Nations and the 'specialized agencies'; and the effective spending of the budgeted 85 million dollars in two years is improbable because of the absence of competent experts in the numbers required.

Both these points, the importance of effective co-operation and of the limiting factor of the numbers of trained men and women available, were well brought out by other speakers also in the House of Lords debate already noted. Lord Tweedsmuir had urged that the fundamental step in Colonial welfare is education of the people for the life of the land, to do the jobs that are most needed in those countries —as medical men, agricultural officers, veterinary surgeons and the like. Lord Rennell commented on the need for not only higher technical staff but also for clerical labour, and in particular on the need for a number of educated people, in addition to those already carrying on the administration of the Gold Coast, which the regional and local government system proposed in the Coussey Report will require.

Lord Milverton doubtless had this consideration in mind when he deplored the forcing of the pace of granting political responsibility by those who do not understand the working of a Western democracy; though he may also have been thinking of the feeling of insecurity created by the report of the visiting mission of the Trusteeship Council to which Lord Listowel referred later when speaking of the need for the right conditions for the employment of capital and technical skill. The debate made manifest the support from all political parties in Britain for the stand which the British Government has made against interference with our administrative responsibilities, and for its determination to consider first the welfare of the indigenous inhabitants; it also demonstrated the general desire to associate with other countries in the co-operative attack on common problems and for the breaking down of whatever psychological barriers hinder such co-operation. It is generally recognized that only on the basis of such goodwill and co-operation can we hope to attack, for example, such problems as that of the control of the desert locust, and, as was emphasized at a recent meeting of the Association of Applied Biologists, an attempt is already being made to bring together on a purely technical basis the twenty governments immediately concerned with that problem.

Similar considerations apply to the International Institute of the Hylean Amazon, which, in the absence of informed world opinion, has suffered from considerable misrepresentation. In fact, the Institute has already made a beginning with its essential task of tropical research, and its pilot surveys in the Gurupá region of the lower Amazon and of the Rio Huallaga are likely to throw light on the possibilities of a region little known to science. But essentially the task of the Institute is that of an international laboratory: it is no part of its responsibilities to build the communications, to raise the commercial crops or provide the capital in accordance with the indications of the findings of its experts. The use made of those findings will depend largely on the initiative and interest of the countries concerned, and principally Brazil. That, in turn, will depend on the appreciation and respect which the Institute enjoys among the countries concerned. Here is a specific task of education. In his summing up on the World Resources Conference, the Dutch representative said, "the Con-

ference has shown the need for co-operation between the technical and the social sciences". That might equally be said of the recent report of the United Nations Economic Survey Mission dealing with the plight of the Arab refugees. Its proposals for finding them useful work in Jordan, Arab Palestine, Syria, Lebanon and the Gaza strip are conceived as part of the larger problem of Middle Eastern unemployment, and, on the lines of the Tennessee Valley Authority's method, five pilot projects are suggested for each area, to be centres for fresh production development.

These proposals, which it should be noted have drawn largely on the practical experience of the British Middle East Office, are again not only a good example of technical co-operation by American, British and French experts, but also a challenge to scientific men as well as to statesmen and politicians. All alike must share in the task of education required to provide the basis for wider and further co-operation. The unhappy experience in dealing with the swollen shoot disease of the cacao trees in the Gold Coast and Nigeria should have shown that the solution of even a scientific problem often cannot be secured without regard to social and political or psychological factors. That experience in turn should predispose scientific workers to follow the discussions now proceeding on the report of the Coussey Committee on constitutional reform in the Gold Coast, to which also reference was made in the House of Lords debate. In so far as wise constitutional reform, which endeavours to preserve what is best in existing constitutions and to effect transition from the old to the new as smoothly as possible, favours the establishment of mutual confidence between all sections of the community in the application of constructive measures for dealing with the problem of swollen shoot and other problems affecting welfare and development, something more than an attitude of benevolent neutrality should be adopted.

The working out of sound, orderly and scientific policies of development by the British Government in co-operation with other countries concerned and with the various 'specialized agencies', particularly the American Economic Co-operation Administration, must depend on informed local support. This, in turn, will help in restoring the confidence and sense of security on which the ready flow to Africa and other backward areas of good administrators and technicians depends.

JAN SWAMMERDAM (1637-80)

Jan Swammerdam (12 Februari 1637–17 Februari 1680)

Zijn leven en zijn werken. Door Dr. A. Schierbeek; met een hoofdstuk: De genealogie van Swammerdam en verdere Archivalia, door Dr. H. Engel. (Nederlandsche Monographieën, 6.) Pp. 280+28 plates. (Lochem: N. V. Uitgeversmaatschappij "De Tijdstroom", 1947.)

THE undaunted Dr. Schierbeek, bombed out of two houses during the Second World War, and lamenting the destruction of his valuable library by a misdirected British bomb, has not allowed these grievous trials to damp his enthusiasm or interrupt his sorties into the history of Dutch biology, which are, on the contrary, more vigorously pursued than ever. He is, in fact, at the moment assisting in the momentous task of reprinting and translating into English the classic works of Volcher Coiter on comparative anatomy, which are now unobtainable in their original form and hence meet for reproduction.

The present treatise is a detailed monograph on the life and researches of the renowned Dutch naturalist Swammerdam, and embraces the following aspects of his personality and work: an attempt by Dr. J. de Boer to determine his psychological category; the genealogy of his family by Dr. H. Engel —surely the most exhaustive analysis of the family tree of any biologist ever written; history of the MS. of the "Biblia Naturæ", which was printed in Dutch and Latin in an edition of 450 copies (here Dr. Schierbeek omits the contemporary testimony of Martin Lister); Swammerdam as a collector and preparateur, and his place in the history of preservation methods and research technique; as a physiologist, and his experiments on respiration and muscle–nerve reactions; as a human anatomist, and on the structure of the female genitalia; as a comparative anatomist, and on preformation embryology; and finally as an entomologist and botanist. A bibliography of his chief works and scattered parerga, and identifications of the species investigated by him, are appended. The last mentioned is a useful addition by Dr. C. A. Regteren Altena, who, however, has no suggestions to offer as to Plate 44, Fig. 7, and Plate 45, Figs. 12–20. The former is probably an immature bug of the family Nabidæ, and the latter, according to Niblett, are the galls of *Andricus curvator*, although the fly said to have emerged from them is too badly drawn to be identified.

Dr. Schierbeek has done his work well, as we should expect from so unwearied a disciple of historical research. Our chief and almost only regret is that the book will not be consulted as its importance demands until it is translated into a more familiar language. Not only have Swammerdam's major works been exhaustively studied and assessed, but Dr. Schierbeek has also exploited his own resources in Holland to hunt down the numerous forgotten fragments which so often repay the tedium of finding them. Also, Swammerdam's intercourse with his eminent contemporaries and the extent of their influence on his own work are adequately set forth. The effect of Anthoinette Bourignon's crazy theology on the susceptible Swammerdam was unhappily not the least potent of these influences, and the fact that she was at the time continuously under the delusion that merciless enemies lay in wait to assassinate her failed to warn her followers of the neurotic and subversive character of her personality. Dr. Schierbeek does no more than catalogue the three-volume novel by Klencke entitled "Swammerdam oder die Offenbarung der Natur. Ein kultur-historischer Roman" (1860), and, although it is true this work is seriously inaccurate, it deserves more than a passing mention. The forged portrait of Swammerdam attributed to Rembrandt was recognized by Harting in 1876 as a copy of one of the figures in Rembrandt's "Anatomy Lesson" painted in 1632, five years before Swammerdam was born. The forger was the eighteenth-century painter Jan Stolker. His forgery was first reproduced in zoological literature in the English translation of

Michelet's "The Insect" of 1874, and has since reappeared in many historical memoirs. Dr. Schierbeek correctly affirms that no contemporary portrait of Swammerdam has so far been discovered. His picturesque birthplace, however, now sadly mutilated by drastic repairs, and even scheduled for future demolition, is shown as it was in Swammerdam's time in an old print in the archives of Amsterdam, which Dr. Schierbeek reproduces. An important matter not mentioned by him is that ten of the plates in the "Biblia Naturæ", which include asymmetrical figures, seriously misrepresent the facts owing to the failure of the engraver to reverse the drawings on the copper plates. Dr. Schierbeek reproduces photographically the original drawings of two of these plates, and, as all of them were available to him in Leyden, it is disappointing that he was unable to reproduce more.

The book is well produced; but the binding in cloth of a dead-black colour gives it a somewhat mournful appearance. The plates are reasonably good copies of the excellent line engravings of the first edition of the "Biblia Naturæ".

F. J. COLE

INTRODUCTION TO ANTHROPOLOGY

Man in the Primitive World

An Introduction to Anthropology. By Prof. E. Adamson Hoebel. (McGraw-Hill Series in Sociology and Anthropology.) Pp. xii+543. (New York and London: McGraw-Hill Book Co., Inc., 1949.) 30*s*.

DURING the past two or three years a very large number of anthropological text-books has come from the United States. Among the most recent of these is this volume by the professor of anthropology in the University of Utah, which claims to be no more than an introduction to the subject, but is nevertheless one of the best. After a brief introduction to discriminate between the various fields of anthropology, an introduction notably useful on the relationship between material and non-material culture and on that between social anthropology and sociology, the book is divided into five parts which deal respectively with prehistory, with race, on which the author's views are eminently sane, with primitive society—a long part, amounting to about three-fifths of the whole volume and divided into sub-heads—and with society and culture, which is really concerned with theoretical backgrounds and practical method. It is perhaps this last part that is the most valuable part of the book, containing as it does a brief critical approach to several aspects of recent developments in anthropological work, developments which hold many pitfalls for the unwary and need the more caution from beginners on account of what might almost be described as their meretricious attractions. A glossary of twenty pages, a bibliography and an index complete the volume.

Occasional points arise which either call for criticism or at least challenge debate. It is surely dangerous, for example, to state categorically that the irrigation of rice is an improvement on a more ancient method of growing it dry. It seems more likely to the reviewer that rice reached Indonesia as an irrigated crop and that its dry cultivation there has taken place by the borrowing of part only of the complex. In his otherwise excellent treatment of the incest taboo, the author omits to mention the reason for royal incest found in the descent of property in the female line, so that a prince must marry his sister, or even daughter, to retain the kingdom. In regard to nomenclature, nothing is said of the common practice of giving names of insignificance or humiliation. The treatment of, or rather the allusion to, trial by ordeal suggests perhaps an incomplete acquaintance with the material and psychological factors involved; and the words "so help me God" of a Christian taking oath are not a conditional curse at all, but an invocation of the Deity for help in making a completely correct statement—very often no easy matter. The two chapters on religion (28 and 29) might usefully have included some account of the doctrine of 'soul-stuff', which has been, and still is, an important element in all the religions of south-east Asia and is, as a matter of fact, much more widely spread, since it appears in all continents; fertility cults are also passed over. In one passage the author speaks of the "reported behaviour" of the lemmings, who "supposedly" travel until they reach the sea and are drowned; but this well-known periodic migration of lemmings has been examined in detail by Collett and is not a myth.

Such criticisms, however, relate to matters of minor detail. The book as a whole forms an admirable introduction to anthropology and can be recommended as such with confidence. It is well printed, well illustrated and well indexed, and the price is, for these days, moderate.

J. H. HUTTON

MODERN SCIENCE FOR THE LAYMAN

Achievements of Modern Science

By Dr. A. D. Merriman. Pp. xii+272. (London and New York: Gregg Publishing Co., Ltd., 1949.) 21*s*. net.

A New Survey of Science

A revised and enlarged edition of 'Science Marches On'. By Walter Shepherd. Pp. 512+35 plates. (London: George G. Harrap and Co., Ltd., 1949.) 15*s*. net.

DR. A. D. MERRIMAN, who was adviser in scientific matters to the commander-in-chief at G.H.Q. Middle East during the Second World War, has produced a work of high quality. In spite of the ambitious title, "Achievements of Modern Science", he has limited himself to a comparatively few recent applications of physics suggested by technical developments during the War. Concerning these he is a master, and he has the gift of clear, simple exposition without the sacrifice of scientific accuracy.

The book will be useful to many classes of reader, from the member of the Armed Forces to the senior grammar school boy. The topics discussed are rockets and space travel, atomic energy, thermionic valves and cathode-ray oscillographs, radar, electron-microscope, magnetism of the earth and degaussing, the aircraft propeller and weather control—a short list, and one that creates a desire for more from the author, particularly as the book costs a guinea. The diagrams in the text are good, and other features of the work are an appendix of photographic reproductions and a coloured frontispiece of F. O. Salisbury's painting of anti-aircraft batteries in action against flying bombs on the Sussex coast in 1944.

Walter Shepherd's book is a new and expanded edition of the author's previous work, "Science Marches On". The book is well produced, and the illustrations are good. It is unfair to expect scientific omniscience from any author; but I feel that in only five hundred pages too much has been attempted, with the result that at times there is both inaccuracy and scrappiness. The author does not lack enthusiasm, and often he is able to present a difficult principle in a clear and simple manner. At other times, he 'starts too many hares' and makes mysteries where none need be. In a chapter intended to throw some light on the nature and development of mathematics, unnecessary difficulties are made concerning the use of simple non-commutative algebra. Elsewhere, the chain of bones in the middle ear (a marvel of anatomical functional efficiency which the author does notice) is described as "a curious little Heath Robinson arrangement", and further on it is stated that "the camera does not *usually* [my italics] record ghosts". Dr. E. D. Adrian is credited with the discovery of the electroencephalographic alpha-rhythm of the brain, average and normal intelligence are confused, an account of the *Gestalt* psychology makes no mention of Wertheimer, Koffka or Köhler, and, surprisingly, the name of Ernst Mach appears as that of a leading nineteenth-century psychologist. These are typical errors.

There is so much useful material in this readable work that the author should subject it to more careful scrutiny and, where necessary, prune it drastically. More attention should be paid to detail. All books on science should be scientific. W. L. SUMNER

THE SCIENCE OF HUMAN SOCIETY

Social Structure

Studies presented to A. R. Radcliffe-Brown. Edited by Meyer Fortes. Pp. xv+234. (Oxford: Clarendon Press; London: Oxford University Press, 1949.) 25*s*. net.

"RADCLIFFE-BROWN," writes Prof. M. Fortes, "has founded or revived teaching and research in social anthropology in all the five continents." The tribute is as well phrased as it is deserved; its simplicity is more meaningful than all the superlatives in the world. The objective of this book is therefore to demonstrate that it is justified, and this has been achieved in full measure.

Prof. A. R. Radcliffe-Brown's work has been that of a man of science who has devoted his life to the creation of an explicit and systematic theory and method of disentangling the complex customs, beliefs and values of societies unfamiliar to the Western world. His aim is to recreate social anthropology "as a branch of natural science", as a "generalizing science" of human social life, directed to the discovery of universal laws. His efforts in this direction have been a welcome antidote to the overstressing of the subjective element in the social sciences, in which it must be confessed that truth has been sacrificed too often to reputation. So far as this goes, his opinion is that "all that a teacher can do is to assist the student in learning to understand and use the scientific method. It is not his business to make disciples." As Prof. Fortes explains, Radcliffe-Brown has never countenanced the growth of an 'ism' or school based on his theories. "There is," to use Radcliffe-Brown's own words, "no place for orthodoxies or heterodoxies in science."

The kinds of problems that are dealt with by the authors of the individual papers illustrate the extent and the limitations of the science that has been developed in this way, and provide useful examples of the application of Radcliffe-Brown's methods to the solution of individual problems. As a whole, the authors accept his conclusion that social structure is the most important part of social anthropology. They base their work on his two principles of method, namely: that general laws can only be discovered by the comparative study of diverse types of society; and that comparative sociology, like any other science, must start from a hypothesis, test it by field-work, modify it in the light of the results obtained and build them into a systematic body of knowledge. The pattern of the essays, therefore, runs from the general to the particular, and back again to the general. This is evident, for example, in Dr. Margaret Mead's contribution on character formation, and in Dr. F. R. Eggan's work on the Hopi and the lineage principle. It is also the foundation on which Prof. M. Gluckman builds his investigation of the role of the sexes in the Wiko circumcision ceremony, a foundation which is even more plainly apparent in Prof. R. W. Firth's discussion of authority and public opinion in Tikopia. Both these latter essays demonstrate how, by applying the methods of scientific research, otherwise meaningless experiences and observations can be organised into a meaningful whole and be made the basis for further research to test extended hypotheses.

The theories that are thus presented are, of course, rather at the beginning than the end of their development. Both the methods and the generalizations of social anthropology are, as Prof. Fortes points out, "very tentative". Most of the problems of method are still unsolved, and it is a great pleasure as well as something of an intellectual challenge to find them faced with the courage and skill which he displays in his most interesting Ashanti case study. His solution of the basic problem of measurement is to hold that "culture . . . and . . . structure . . . denote complementary ways of analysing the same facts". The former, he argues, gives us the qualitative aspects of social facts; the latter, on the other hand, is "most appropriately applied to those features of social events and organizations which are actually or ideally susceptible of quantitative description and analysis". This formulation presents almost as many difficulties as it clears up; but before the ardent young intellectual begins to pick holes in it, he should ask himself how he can replace it with something better. It is certainly of a somewhat crude and rule-of-thumb order; but it is a step in the right direction in so far as it will lead, if it is followed up, to a clarification of concepts of which the social sciences stand in somewhat desperate need.

It is probable that further analysis of the problem of method will also bring with it a more sophisticated conception of the nature of the anthropological 'laws', the formulation of which has exposed Radcliffe-Brown to such sharp criticism. What is wanted from the anthropologist in the future is, therefore, that the excellent work that has been accomplished in the past fifty years should be continued in the future with even more emphasis on the strengthening of the theoretical foundations on which it rests.

T. S. SIMEY

JUBILEE OF THE NATIONAL PHYSICAL LABORATORY, TEDDINGTON

ON January 1, 1900, Richard Glazebrook took up appointment as director of the National Physical Laboratory. The Laboratory was then at Kew, but shortly afterwards moved to its present site at Teddington. Its formal terms of reference specified its work as being the standardization and verification of instruments, the testing of materials and the determination of physical constants; but in his speech at the opening of the new buildings at Teddington in March 1902, the Prince of Wales, later King George V, said:

"The object of the scheme is, I understand, to bring scientific knowledge to bear practically upon our everyday industrial and commercial life, to break down the barrier between theory and practice, to effect a union between science and commerce. This afternoon's ceremony is not merely a meeting of the representatives of an ancient world-renowned scientific society for the purpose of taking over a new theatre of investigation and research. Is it not more than this? Does it not show in a very practical way that the nation is beginning to recognize that if its commercial supremacy is to be maintained, greater facilities must be given for furthering the application of science to commerce and industry?"

These words were prophetic. The National Physical Laboratory, during its fifty years existence, has not only fulfilled its formal mandate but has also given Great Britain the type of service foreshadowed by the Prince of Wales.

Early in 1900 the staff of the Laboratory was about twelve, and to-day it numbers more than 1,100; but the service it has rendered to the nation, and particularly to industry, cannot be measured merely by this increase in size.

The National Physical Laboratory, unlike most other Government scientific establishments, is organised on the basis of subjects, rather than the service of particular objects. Thus the Building Research Station, for example, is concerned with the application of science to the art of building; but there is no formal limitation to the scope of the National Physical Laboratory, save that its investigations should serve the community through subjects represented by its ten divisions. It is undoubtedly the case that the value of the Laboratory has depended not only on the existence of its specific divisions, but also because those divisions are housed together under the leadership of one director. Despite the fact that the divisions are in many ways almost autonomous, the work of each is influenced greatly by that of the others, and the fact that between them they cover much of the field of physical science has enabled the Laboratory to be the seed-bed in which numerous researches have germinated and grown until they were sufficiently vigorous to lead a separate existence elsewhere. Thus, valuable work which started in the National Physical Laboratory was later transferred to the Road Research Laboratory and the Building Research Station. In more recent times, Sir Charles Darwin, fearing the possible cessation of loose-boundary hydraulics research in Great Britain, instituted work on this subject which was, in due course, transferred to the control of the Hydraulics Research Organisation. It is only lack of facilities elsewhere which is delaying the transfer of the radio work of the Laboratory to the formal care of the Radio Research Organisation. This applies also to the transfer of much of the work of the Engineering Division, and some of the work of the Metrology Division, to the Mechanical Engineering Research Laboratory which is being established at East Kilbride.

In many research establishments the needs are determined by higher authority; but in an establishment working primarily for the general welfare of all industry, and organised by subjects, the needs and problems must, in general, be recognized and formulated by the research workers. The latter is the case in the National Physical Laboratory, which, in this sense, therefore, is similar to a university; but it has been able to meet some needs beyond the scope of universities in the past. The staff, being members of the Scientific Civil Service, have been able to carry on long-term research on a more stable basis than in many universities, where the nature of the research can change suddenly with changes of staff. Also, the possession of large-scale and expensive equipment, most of which was previously beyond the reach of universities, has enabled the Laboratory to work on subjects which universities could not tackle.

In addition to its long-term research, the National Physical Laboratory has fulfilled a very real need in the service which it provides for carrying out special investigations for other government departments and industry. To some extent, therefore, and within its own sphere, it has enabled industry to pay directly for research on subjects where no one firm could provide the necessary facilities. The recent rapid increase in the number of the industrial research associations, numbering no less than forty, has in no way diminished the need for the more fundamental type of work associated with the National Physical Laboratory, in which it endeavours to undertake work meeting the requirements of industry as a whole, leaving to the research associations the direct contact with particular firms. This does not, of course, imply that the research associations are not themselves doing fundamental work; but close collaboration is maintained between the Laboratory and many of the associations, and thereby much possible duplication of effort is avoided.

In addition to its important role in the maintenance of the physical standards, the National Physical Laboratory continues to serve industry by testing and verifying instruments and materials. Much of this work can now be done in the production industry concerned, but the Laboratory has an increasing responsibility in setting the standards for such work, and is prepared in appropriate cases to assist industry to carry out its own tests and verifications by defining and verifying the sub-standards needed for this purpose, and by keeping a sample check on the products. Thus it is the constant aim of the Laboratory to provide those services which industry is not already able to supply on its own account. In some ways the high reputation which the Laboratory has earned is now an embarrassment, because purchasers, especially those in foreign countries, often demand National Physical Laboratory certificates when industry itself is competent to certify its own products.

As is well known, for the first seventeen years of its life, the National Physical Laboratory was under the

direct control of the Royal Society. In 1918 it was absorbed into the then newly formed Department of Scientific and Industrial Research; but the 'management' of the scientific work of the Laboratory remained the responsibility of the Royal Society, the president and Council of which, acting on behalf of the Privy Council Committee for Scientific and Industrial Research, even to-day appoints the General Board and Executive Committee of the Laboratory. This collaboration between a learned society and a government department is possibly unique. It is certainly a source of surprise to many visitors from overseas; but they agree that this arrangement produces the desired results. The collaboration of the Royal Society and the Department of Scientific and Industrial Research in this connexion was well illustrated by the fact that a reception held on January 30 to commemorate the fiftieth anniversary of the founding of the National Physical Laboratory was sponsored by His Majesty's Government, but was held in the rooms of the Royal Society. The guests were to have been received jointly by the Lord President of the Council, the Minister responsible for the Department of Scientific and Industrial Research, and the President of the Royal Society. Unfortunately, the Lord President was unable to be present to receive the guests, but joined the company later in the evening.

Much has been written and broadcast recently on the work of the Laboratory, and it is not necessary to repeat this; but exhibited at the reception at the Royal Society's rooms were apparatus, diagrams and pictures illustrating the principal work of the Laboratory since its inception. Pride of place was taken by exhibits representing the Laboratory's most important work—the maintenance of the fundamental standards of mass and length, and of derived standards; particularly interesting were those showing the movement from material to physical standards, as in the cases of the standards of length and light. The method of making precision block gauges and the accurate measurement of angles was demonstrated, as was also progress in the design of engineers' measuring instruments, and such recent developments of measuring methods as the continuous measurement by an air gauge of materials in thread or wire form. Work on fluid flow was represented by exhibits of Stanton's work on compressible flow; models of cargo vessels and illustrations of the laminar and turbulent flow of water around ships' hulls; the development of wind tunnels and wing shapes; work on aircraft stability and control, and on flutter; and examples of investigations in the high-speed laboratory.

Throughout the whole, the work of the National Physical Laboratory in the development of instruments was evident, and here exhibits illustrated work on heat-transfer problems; the measurement of temperature; the precise calibration of microphones; and radiation measurement in connexion with the protection of radiological workers. Larger equipment showed developments in the technique of the measurement of creep of metals over the past thirty years, and one item of the Laboratory's war-work was illustrated by a prototype of bomb disposal apparatus.

Work of general importance, both in industry and the home, was illustrated by exhibits on heat-transfer investigations, including problems relating to refrigerated transport; sound insulation and noise reduction; the development of light alloys and research on calorimetry. Work on high-voltage measurements, devices for frequency measurement, and instruments for the investigation of dielectrics were shown, as well as illustrations of the progress of research in radio-wave propagation and direction-finding, and radio aids to meteorology. Progress in work on the development of an automatic computing engine was illustrated by a simulator, using relays instead of valves.

An exhibit organised by the Test House showed the testing and certification for industry of instruments such as barometers, hydrometers, thermometers, volumetric glassware, taximeters and petrol jets.

Being largely commemorative, the exhibits dealt mainly with the past work of the National Physical Laboratory—or the 'N.P.L.', to use its familiar title. Its future lies along the road of further applied research in the physical sciences, with particular reference to those problems needing special instrumentation and exact measurement, not only to fulfil the known needs of industry, but even more to provide within its sphere the basic knowledge which is the foundation on which future industrial development will be built.

SEVENTH INTERNATIONAL CONGRESS FOR APPLIED MECHANICS, 1948

THE Seventh International Congress for Applied Mechanics was held at South Kensington, London, in the Imperial College of Science and Technology, during September 5–11, 1948. Among the 882 members who enrolled were large numbers from the United States, France, Holland, Italy, Belgium, Sweden, Czechoslovakia and Poland. Altogether, twenty-nine countries were represented. In spite of the fact that many more people came than previous experience led the organisers to expect, the arrangements worked smoothly. The problem of accommodating so large a party was made easier by the action of the authorities of the Imperial College, who allowed members and their wives to stay in the students' quarters. The task of seeing that everyone, including a large proportion of foreign members, knew what to do and where to go was efficiently carried out by some of the staff and students of the College.

The number of scientific papers presented was so great that it was necessary to divide them into five groups and to maintain each group in continuous session during the working hours of five days. The scientific communications were of two kinds. Five general lectures, intended to cover recent work on subjects which are advancing rapidly at the present time, were delivered by invited lecturers, and 228 shorter papers were given by members about work with which they were connected. The "Proceedings" of the Congress* have now been issued in six volumes, which include nearly all the papers presented. They are not printed but are reproduced photographically

* Proceedings of the Seventh International Congress for Applied Mechanics, London, September 1948. Introductory Vol., pp. 129; Vol. 1, pp. 9–432; Vol. 2, Part I, pp. 320; Vol. 2, Part II, pp. 321–644; Vol. 3, pp. 312; Vol. 4, pp. 356. (London: Organising Secretary, Seventh International Congress of Applied Mechanics (1948). Imperial College of Science and Technology, 1949.)

from typescript provided by the authors. This process involves reducing all pages to the same size, so that the height and spacing of the letters vary from one paper to the next. The Editorial Committee accepted this want of uniformity in order to gain the great advantages of quick publication and low cost. In all cases, even when the author used small type on a large sheet, the typed letters can be read; but formulæ which have been hand-written by their authors are sometimes difficult to read when reproduced on the reduced scale.

Of the five general lectures, three are published in full in the introductory volume. Two of these lectures, by J. Kampé de Fériet and G. K. Batchelor, are on different aspects of turbulent flow in fluids, and the third, by M. Hetényi, is on the present state of development of stress analysis. The two lectures by W. Prager, on recent developments in the theory of plasticity, and by M. J. Lighthill, on high-speed gas flow, are being published elsewhere. An abstract of W. Prager's lecture is printed in the "Proceedings", but M. J. Lighthill's lecture is not referred to, owing, it is understood, to an unfortunate oversight. These lectures illustrate the wide variety which exists in the methods of approach employed by the devotees of applied mechanics. Kampé de Fériet discusses in a most general way the properties of the tensors associated with the spectra of turbulence, and he treats the subject as an exercise in pure mathematics without referring to measurements in actual fluids. Batchelor, on the other hand, avoids mathematics where he can, and concentrates on analytical discussion of experimental work. Prager discusses, from an analytical point of view, the kinds of situation which arise when bodies with ideally defined plastic and elastic properties are strained. Hetényi describes the experimental techniques used to measure distributions of strain which occur in materials as they are used in engineering practice. Lighthill considered the powerful mathematical techniques which have been developed in recent years, partly by himself, for discussing fluid flow at supersonic and high subsonic speeds.

Of the 228 shorter papers presented at the Congress, 211 are published either in full or as abstracts in Vols. 1–4 of the "Proceedings". Vol. 1 contains sixty papers on elasticity and plasticity; Vol. 2 seventy-six papers on aero- and hydro-dynamics, being bound up in two parts; Vol. 3 thirty-two papers on thermodynamics, including heat transfer; and Vol. 4 forty-three papers on dynamics, experimental methods and numerical computations.

Reading the papers in Vol. 1 leaves the impression that the assumptions of the classical theory of elasticity, namely, that strains are small and stresses obey Hooke's Law, no longer satisfy many workers in this subject. Great mathematical difficulties arise as soon as these assumptions are abandoned, and materials are assumed to have properties more like those which occur in Nature. Vol. 1 contains examples of solutions of problems involving large strains in bodies which possess ideal elastic properties, problems about bodies with simple geometrical forms and not-so-simple plastic properties, and bodies with ideally simple plastic properties but less simple geometry. It also contains papers like that of A. M. Willis, on the instability of hollow rubber cylinders with axial symmetry, in which no attempt at analysis is made but interesting experiments are described. Many of the papers relate to practical engineering problems like the buckling of straight columns, the behaviour of continuous beams, the stresses in buildings due to wind load and the behaviour of cantilever spars with shear-resisting skins.

The great variety of problems discussed in Vol. 1 makes it difficult to discern any definite trend in research in elasticity and plasticity. Elastic stability still attracts a number of workers, and the elastic behaviour of structures after suffering collapse due to instability is discussed by A. van der Neut. Two-dimensional problems of flow in an ideal plastic material are considered by R. Hill in several cases where the total strain is large. Plastic waves produced by impact at the end of a wire or rod which possesses a well-defined yield point are discussed by M. P. White and shown to give rise to some curious distributions of permanent strain. Z. Horak writes on the impact of a ball falling vertically on a horizontal plane when it is spinning about a vertical axis.

Vol. 2 contains seventy-six papers, of which twenty relate to flow of compressible fluids, eleven to turbulent flow, six to boundary layers and four to flow with a free surface. The great interest taken in the effects of compressibility was stimulated, no doubt, by the fact that aeroplanes now fly up to, and even faster than, the speed of sound. Fortunately, the subject has proved interesting to some very able young mathematicians who have been willing to keep in touch with experimentalists. The present volume contains evidence that their efforts have proved so successful that it is now possible to understand supersonic as completely as subsonic flow. Among the experimental methods available for studying the flow of compressible fluids, the interferometer, which measures density, has been developed to a high pitch of efficiency by R. Ladenburg, who gives some good examples of its use.

The study of turbulent flow has proved a fertile ground for mathematicians as well as experimentalists. The dynamics of statistically isotropic turbulence, which is very nearly produced experimentally in a wind tunnel by making the air pass through a grid of regularly spaced obstacles, form the subject of papers in the "Proceedings" by Kampé de Fériet, Batchelor, F. N. Frenkiel and C. Lin. In this, the simplest case of turbulent motion, the turbulence is carried along bodily in the air stream, and the dynamical discussion concerns the action of the eddies on one another. The more complicated cases where the mean flow varies from point to point have not yet proved amenable to theoretical treatment; but measurements of turbulence in such cases are here described by A. A. Townsend and by J. O. Hinze and B. G. van der Hegge Zijnen. The effect of damping screens in reducing turbulence is considered by M. L. Dryden and G. B. Schubauer.

A paper by Garrett Birkhoff describes some developments in the theory of fluid flow bounded by free surfaces. The shape of the cavity which can exist behind a body in a stream of fluid is discussed, and the jet theory of the action of a hollow explosive charge lined with metal is explained. Problems involving surface waves are considered by F. Ursell, who gives a theoretical account of the waves produced by the rolling of floating bodies, and by K. S. M. Davidson, who explains why it is that a following sea makes steering difficult in some ships.

Vol. 3 contains thirty-two papers on thermodynamics and heat transfer. Heat transfer between a solid and gas flowing past it at high speeds is rendered a difficult subject by the fact that heat is produced in the boundary layer, and since both

conductivity and viscosity depend on temperature, the equations representing the distribution of velocity and temperature near the solid surface are complicated. W. F. Cope summarizes the results of calculations which he made with D. R. Hartree, and gives numerical examples illustrating the difference between these calculations and the earlier ones of Pohlhausen. The measurement of the temperature of low-density gases moving at high speeds presents considerable difficulties. If the gas is slowed down and a thermocouple is placed in a region of slow flow, the temperature there can be corrected to give the temperature in the fast-moving gas ; but the heat transfer from the gas to the thermocouple is so slow that the measured temperatures lag behind the true temperatures. J. E. P. Dunning describes a thermometer in which gas is forced to flow over a thermocouple at sonic speed by applying suction to a pipe surrounding it. This measures nearly the same temperature as the slow-flow thermometer but suffers much less from thermal lag.

Recent progress in the problem of knock in internal-combustion engines is described by Sir Alfred Egerton and N. P. W. Moore. Comparatively simple conceptions like those evoked to explain the experiments of Tizard and Pye cannot explain what is observed when an engine knocks. Chemical actions take place during the compression stroke which 'pre-sensitize' gas which has not yet been touched by the combustion flame. Antiknock compounds affect this gas but do not affect the rate of propagation of the combustion flame. A simple method for measuring the conductivity of liquids is described by E. F. M. van der Held and F. G. van Drunen. This method is useful for corrosive liquids which would damage apparatus commonly used for measuring heat conductivity.

Vol. 4 contains forty-three papers on dynamics, experimental methods and numerical computations. The subjects range from the use of matrices for calculating oscillations of complex elastic structures to papers on the strength of reinforced plastics and a description of a 50-ton dead-weight standard of load for calibrating testing machines. An interesting paper by L. S. Wasserman compares accelerations measured at points on the wing tips and other parts of an aeroplane while landing with accelerations computed theoretically from known elastic characteristics of the machine. Diagrams in this paper show that, in certain positions on the aeroplanes tested, very large accelerations, up to $8g$, occur on landing.

The calculation of the speed at which flutter may be expected to occur in an aeroplane wing has for some time exercised the minds of aeronautical engineers. In the present volume W. Barrois, J. Simon-Suisse and their colleagues give an account of the numerical methods used in France in making these calculations. They also describe electrical analogues which can be used in this connexion. Among the purely experimental papers, one by C. Mylonas on the distribution of stress in glued joints opens new ground. The stresses in the transparent glue are determined by photo-elastic methods.

The high quality and great variety of the papers in these volumes provide evidence that the science of applied mechanics has plenty of vitality, and that it is attracting the attention of many young people, as well as holding the interest of the older workers. The Congresses for Applied Mechanics are usually held at four-year intervals, and the next one will take place in Istambul in 1952. G. I. Taylor

COMMONWEALTH CONTRIBUTIONS TO THE BRITISH DIET

THE Nutrition Society, at its meeting in the London School of Hygiene on January 28, discussed what the British Commonwealth could do to feed Great Britain. In the morning session representatives from those Dominions which are the principal contributors to the British diet, and representatives of the West Indies and the Overseas Food Corporation gave the meeting details of what they are already contributing and what they may be able to do in the future. In the afternoon, the morning papers were discussed, commodity by commodity, by British experts on various foodstuffs. A most valuable symposium resulted.

The meeting opened with a paper by Lieut.-Colonel J. G. Robertson, speaking on behalf of Canada. His Dominion, he said, is the second largest country in the world, but it has a population of only about thirteen and a half million people ; it is therefore a large exporter of food. He explained in some detail the remarkable contribution which Canada made to the solving of the British food problem during the Second World War. To do this she greatly increased her production of many foods. In 1938 she exported 160 million lb. of bacon, and by 1944 she was exporting 660 million lb. to Britain ; cattle marketings were virtually doubled, and Cheddar-cheese production increased by 58 million lb. Canada has also sent a considerable variety of foods to Britain, including wheat, flour, bacon and hams, beef, mutton and lamb, poultry, eggs (shell and dried), cheese, evaporated milk and milk powder, fruit, vegetables, lard, salmon, honey and maple products.

Colonel Robertson also pointed out that during the war years Great Britain found it impossible to pay for all her war expenditure (arms, equipment and so forth) and still meet the bill for her food supplies. Canada helped her unstintingly in the financial field by making gifts of more than two thousand million dollars and interest-free loans of more than one thousand million and also by conversion of certain British assets in Canada into cash to the tune of some four thousand million dollars. So by these means during the War, Great Britain was able to obtain most of her food imports from Canada without actually paying for them. It is important, in appreciating the great effort made by Canada to help Britain during the War, to realize how unfortunate is the dollar position to-day, which forces Britain to buy in soft-currency markets, and to leave a food industry in Canada, greatly expanded to meet the mother country's war-time requirements, with virtually no markets for many of its products.

The Canadians are also faced with the sight of dollars provided by Marshall Aid being compulsorily spent in the United States on foods which Canada has in abundance for export. In recent years, Canada has added millions of acres to the area of grain production by the development of early maturing varieties of wheat and by creating new varieties of rust-resistant wheats. In this way she has made possible the addition of hundreds of millions of bushels to the cereal supply of the world. Given a proper incentive, the Canadians could divert their food production into whatever channels that are required. For example, they could decrease beef production and increase pork products ; they could increase wheat acreage at the expense of oats, barley

and rye, and so on. In fact, Colonel Robertson gave the meeting a picture of Canada as a country stacked with surplus wheat, cheese, butter, bacon and hams, eggs, beef, apples, preserved fruits, salmon—a list to make British austerity mouths water—and inhibited only by the barrier of dollar exchange from pouring these dietetic treasures into British laps.

Australia's contributions to the British table were described by Mr. A. H. Heywood, of the Australian Meat Board. Here no dollar difficulties arise, and we find that in the ten months ending in October 1949 Great Britain received from this Dominion 1¼ million cwt. of butter, nearly 400,000 cwt. of cheese, 80,000 cwt. of processed milk, more than twelve million dozen eggs, more than 3 million cwt. of meat (including poultry and rabbits), about 20 million cwt. of cereals, nearly 5 million cwt. of sugar, and more than 700,000 cwt. of dried and canned fruits, not to mention nearly a million gallons of wine. Gargantuan as these quantities of food are, few of the items represent more than twenty per cent of the total import of these particular commodities. Australia also sends miscellaneous products such as edible tallow, copra, whale oil and other fats, fruit juices, jam, tomato products, cakes and puddings. The volume of fruit cake and Christmas puddings exported to Great Britain last year was very great—£1 million worth of fruit cake, together with eight million Christmas puddings. Another significant contribution which Australia makes to the British diet is in food parcels, the price of which is subscribed by the Australian people and therefore costs the recipients nothing. During 1940–48 more than eleven million gift parcels were sent to Great Britain from Australia. The parcels vary between seven and eleven lb. each in weight, and they are still being sent at a yearly rate of about three million. In fact, the parcels use so much meat in the tinned meat which is included in them that the Australian authorities are a little uneasy about the effect of the subtraction of the large amount of meat involved from the normal export channels.

Australia could increase the amount available for export of many of the foods which she sends to Britain; but Mr. Heywood told the meeting that it is in the production of meat that Australia is being looked upon to make the greatest contribution to the diet of Great Britain, which, he remarked, is by tradition a nation of meat eaters, though the meat producers of Australia are a little disturbed by the possibility that the extended rationing of meat in Britain may produce a generation which has lost its taste for meat. The export surplus of mutton and lamb from Australia is largely dependent upon the price of wool. The high prices for this commodity which have prevailed in recent years (due to the fact that the rest of the world still turns to Australia for about two-thirds of the total requirements for fine wool) has caused a rise in the sheep population from its low level of 96 million in 1946 to about 110 million now. Thus it would appear that a great increase in the production of mutton and lamb is possible in the near future. Nevertheless, it is in the increased production of beef that the best prospects are presented. There are vast areas in Australia which, because they are not suitable for the production of wool, remain to be developed for cattle. This is a long-term process; but measures to stimulate production in the near or immediate future are being actively promoted.

Dr. C. Hopkirk dealt with New Zealand's food contributions. This Dominion does not export grain, but in dairy products she makes a major contribution, sending in 1949 140,000 tons of butter and ninety thousand tons of cheese. In 1948 the United Kingdom's imports from New Zealand represented (as percentage of the total imports) butter, 50; cheese, 53; lamb, 65; and mutton, 77; the figure for beef, however, is only 17 per cent. New Zealand is at the moment in a period of seven-year agreements with Britain, of which five years have still to run. Within the scope of this agreement the Dominion is aiming at an annual increase of two per cent of dairy products and an increase of fifty thousand tons of meat. To some extent, of course, this projected increase is governed by the seasons. It so happens that the year 1949 was the best year known for dairy products. In general, the future for increased food production in New Zealand is bright, and there is every possibility that the targets set will be achieved or even exceeded.

The case for South Africa was put forward by Mr. A. P. van der Post. The Union is not, he said, naturally a rich agricultural country, and even to-day is dependent for its bread upon the importation of wheat. There are a great variety of climate and great vicissitudes of Nature. The type of sheep found in South Africa is not the mutton-producing type, and mutton and lamb are, therefore, not to-day sent to Great Britain; nor is beef, since the Union lacks natural vegetation on which the beef cattle can be 'rounded off'. Butter used to be exported to Great Britain in small quantities before the Second World War; but drought and increased local demand in recent years have accounted for all of the Union's production of this commodity. Before the War the Union sent 4–6 million dozen eggs to the United Kingdom, a relatively small proportion of the total imports; but they arrived at a time when supplies from other sources were scarce. It is hoped to increase egg supplies again. It might be possible to supply pork and pork products again, if supplies of maize for use as a feeding-stuff can be assured. The Union supplies substantial amounts of whale oil to the United Kingdom, and an important post-war industry is the production of fish liver oils. Union fish-canners hope eventually to provide greater variety of canned fish for export. Sugar is also exported to Britain, and fruit and fruit products (for example, jam, marmalade, canned and dried fruit, fruit pulp and fruit juices) can be supplied in substantial amounts. Mr. van der Post felt that while the Union cannot hope to equal the record of certain other countries in the supply of large quantities of basic foodstuffs to the United Kingdom, it nevertheless can make a substantial contribution partly in basic and partly in semi-luxury foodstuffs to give variety to the British diet.

Dr. L. F. Wiggins spoke on the West Indian contribution to the British diet and pointed out that, although it sends bananas, cocoa, citrus fruits, coconuts, tinned fruit juices, tomatoes and rum, its main contribution is, of course, sugar. He spoke of the economic difficulties produced by the rapid increase of the West Indian population and stated that one way of increasing the prosperity of the various islands which make up this Colony would be to create new industries based on sugar. Reference in this connexion may be made to the food yeast factory which was set up there. A large variety of organic acids can also be produced from sugar, and also substances such as potassium acid saccharate, which can be used as a substitute for cream of tartar.

The work of the Overseas Food Corporation was outlined by Mr. N. R. Fuggles-Couchman, who remarked that a great deal of publicity has been given to the difficulties met with in connexion with the groundnut scheme, but very little to the very successful sorghum-growing activities centred in the north-east State of Australia, Queensland. He pointed out that it is intended to sow groundnuts in Africa in rotation with other crops such as sunflowers, sorghum and so on, and possibly soya beans. Oil-palm cultivation on a large scale has not been undertaken because of the long period (about seven years) before any return can be expected. It is hoped in the not too distant future to provide an annual oil production of about 57,000 tons, which is still only a little more than a tenth of the estimated deficiency of fats. In Queensland 480,000 acres of land have been purchased since March 1948, and it is proposed to grow sorghum, sunflowers and soya beans and other crops for export to Britain. Pigs and store-cattle are being fattened on sorghum to provide extra bacon and meat. It is also proposed to export sorghum direct to the United Kingdom, where it can be used for fattening stock on the spot.

During the afternoon of the meeting, various commodities were discussed as follows: meat, Dr. John Hammond; fruit, Dr. R. G. Tompkins; cereals, Dr. Albert Green; dairy products, Dr. E. C. Capstick; fats, Dr. C. H. Clarke; bacon, Dr. E. C. Callow; and sugar, Mr. Phillip Lyle. It is impossible to discuss the remarks of these speakers in any detail, but reference may be made to one or two items of interest. Dr. Hammond, for example, pointed out that Great Britain is more dependent now (fifty-five per cent) on overseas meat than before the War, and that the home production of pigs contributes virtually no pork, since all the carcasses are converted into bacon. Dr. Green said that Australian wheats are surprisingly low in protein, and that the protein value of Canadian wheat depends upon whether it comes from the west or east coast. The former contains one per cent less protein, and if, for example, Britain obtained all its Canadian wheat from the west instead of the east, it would cost the public 45,000 tons of protein in a year.

As Dr. Callow pointed out, the Commonwealth supplies of bacon last year represent only about eighteen per cent of the total requirements, and if it is assumed that the present bacon ration in Britain remains at 5 oz. for a year, the Commonwealth contribution, if it does not increase, will represent only ten per cent of the requirements. The difference can only be made up by increased home production or further imports from outside the Commonwealth. Dr. Tompkins said that fruit consumption in Great Britain has fallen from 92 lb. per head before the War to 76 lb. now, of which half is home grown. Dr. Capstick thought that the Dominions had done a wonderful job during the War in helping with the varying demands in Britain for dairy products. He said that the present market is more or less saturated for the type of cheese now being supplied, and that Commonwealth cheese makers might consider shipping varieties other than Cheddar. Another point of interest which he made is that sixty thousand tons annually of pre-war butter in Britain came from countries which are now behind the 'iron curtain', and that this has to be made up from other sources.

The meeting was reminded by Dr. C. H. Clarke that there is a world shortage of oils and fats. Although the *per capita* availability of fat for edible purposes is about equal to pre-war, there is a considerable shortage of soap. Greater use of detergents would not free more fat for food because only low-grade fats are used for soap making. Whale oil at the moment can only be used for food purposes. Hydrogenation provides us with a means of obtaining an enormous variety of fats and oils. Mr. Phillip Lyle said that increased production of sugar in the West Indies comes, not from planting more extensive areas, but by more intensive and improved methods of cultivation of areas already planted. He said that, although the food yeast factory is a good idea, it is difficult to persuade West Indians to eat its product. Some of this is being sent to Great Britain and is sold to manufacturers. The cause of the rise in prices is that there is not sufficient demand for the product to keep the factories working full time.

Dr. W. K. Slater (chairman) wound up an admirably conducted meeting by stressing the difficulties that will arise in feeding the British population as increased home demands are made for various foodstuffs in the countries producing them, and which at present have an exportable surplus that is sent to the United Kingdom.

NEWS and VIEWS

North Staffordshire University College: First Appointments

THE following full-time professors have been appointed in the new North Staffordshire University College which is to be opened in August at Keele, near Newcastle-under-Lyme: Mr. W. B. Gallie, senior lecturer in philosophy, University College, Swansea (*philosophy*); Mr. A. E. Teale, lecturer in philosophy, University of Manchester (*political and moral philosophy*); Mr. I. N. Sneddon, lecturer in natural philosophy, University of Glasgow (*mathematics*); Dr. H. D. Springall, senior lecturer, University of Manchester (*chemistry*); Mr. J. W. Blake, senior lecturer in history, Queen's University, Belfast (*history*); Mr. J. J. Lawlor, lecturer in English in Brasenose and Trinity Colleges, Oxford (*English*); Mr. W. W. Chambers, lecturer in German, University of Leeds (*modern languages*); Mr. S. E. Finer, tutor and research fellow, Balliol College, Oxford (*political institutions*); Mr. S. H. Beaver, reader in economic geography, London School of Economics (*geography*); Mr. B. R. Williams, lecturer in economics, Queen's University, Belfast (*economics*); Dr. V. A. Vick, senior lecturer in physics, University of Manchester (*physics*); Dr. A. R. Gemmell, lecturer in botany, University of Manchester (*biology*); Mr. W. Stewart, lecturer in education, University College, Hull (*education*).

Inland Water Survey Committee

THE Minister of Health, Mr. Aneurin Bevan, and the Secretary of State for Scotland, Mr. Arthur Woodburn, have reconstituted the Inland Water Survey Committee, with membership as follows: Major-General G. Cheetham (*chairman*), Mr. R. H. Cuthbertson, Mr. A. A. Fulton, Mr. W. H. Haile, Mr. M. G.

Ionides, Captain W. N. McClean, Mr. J. D. Peattie, Mr. N. J. Pugh, Mr. L. A. Rhodes, Prof. L. Dudley Stamp and Mr. C. A. Wilson, with, as secretary, Mr. M. R. P. Gregson. The terms of reference of the Committee are to "advise on the Surface Water Survey of Great Britain, on the progress of the measures undertaken, and on further measures required, and, in particular, to make an annual report on the subject". The object of the Survey is to make available to government departments, water undertakers, industry, agriculture and to all who need it, information about the yield, behaviour and quality of the water resources of Great Britain. For the present the Committee will be concerned in the main with surface water. The field-work will be undertaken by the new river boards, which are given wide powers for the purpose, and by water users.

National Foundation for Scientific Research, Brussels

THE twenty-first annual report of the National Foundation for Scientific Research, Brussels, covering the year 1947–48, includes the customary lists of members of the Council, bureau and scientific commissions, and details of research grants made during the year and of publications during 1946–47 and 1947–48. There is also an analysis of the grants made since the creation of the Foundation in 1927 by subjects and by institutions, as well as the first report from the Inter-University Institute of Nuclear Physics established in July 1947. The scientific work of the latter Institute at the Brussels centre has been concerned with photographic plate technique and cosmic rays, with X-ray counters, the separation of isotopes by thermo-diffusion and biological studies of the nucleotides of ribonucleic acid with radio-isotopes. At the Ghent centre an automatic Wilson chamber has been constructed, and the diffusion of neutrons and a new Geiger–Müller counter have been studied, while at Liège the purification of uranium, the fission products of uranium and their concentration and the use of the photographic plate in nuclear physics have been among the subjects investigated. At Louvain, the separation of isotopes, the preparation of organic compounds of uranium, nuclear isomerism, and fluorine derivatives of uranium, and at Mons vacuum pumps, Geiger counters, sources of ions and electronic apparatus, have received attention. Some of these subjects have also been studied at the Royal Military College. Special grants were made by the Foundation during the year for a study of the effect of monochromatic X-rays on the phases of cellular division (205,000 francs), for the establishment of a Centre of Eastern Belgian Dialectology (150,000 francs), to the committee responsible for the preparation of an onomatological dictionary of ancient France (120,000 francs), to the provisional committee for the study of alimentation and nutrition of the indigenous peoples of the Belgian Congo (200,000 francs), and for the reconstitution of the collection of photographs of Coptic documents and manuscripts (50,000 francs).

American Imports of Indian Jute

AN "Economic Analysis of the American Market for Jute and Jute Manufactures", by D. Ghosh, has been issued as Economic Research Memoir No. 2 by the Indian Central Jute Committee, Calcutta (pp. 36, 1949, 1.4 rupees). India is the largest supplier in almost every section of the American jute trade, and although the American market is predominantly one for burlap, there is a large demand for raw jute, and bags and sacks. The study is an attempt to understand the nature of this important market, especially to discover basic relations and interpret broad movements in terms of those relations. While essentially exploratory, it indicates that the aggregate value of imports of jute and jute manufactures into the United States is governed by the same forces as regulate the size of the American national income and determine the value of American imports in general. Moreover, the quantity of the imports changes more or less in the same manner as the physical volume of American industrial production, but the American demand for jute and jute goods tends to increase rather more than proportionately with a rise in the level of income and industrial activity. A statistical note on the demand for hessian in the United States is appended.

Planning in the Fuel Industries

IN an address to the Fuel Luncheon Club on December 20, Lieut.-Commander C. Powell, administrative secretary of the Parliamentary and Scientific Committee, after describing the way the Committee works and some action taken by it in recent years, dealt more particularly with the fuel industry, on which the Committee has already issued three reports. Commander Powell summarized some of the recent statements on coal production for costs, coal utilization, oil from coal, domestic fuel efficiency and the co-ordination of research in gas, coal and the electricity industries, which appear to constitute a serious challenge both to the Committee and to fuel technologists. Exactly what is the best policy to follow, either in the short term or in the long, appears to be unsettled; but the Parliamentary and Scientific Committee is prepared to consult with the experts concerned. In particular, there is still before the Committee the memorandum prepared in 1947 by the Combustion Appliance Makers Association, which maintained that twelve million tons of coal a year could be saved by introducing efficient central-heating equipment and up-to-date domestic fuel burning appliances.

The Young Gannet

ALTHOUGH a great deal is known about the activities of the young gannet (*Sula bassana*) from the day of its birth to the day when it takes to the sea, few observations have been made on its behaviour during the following two or three weeks. During the autumns of 1947 and 1948, G. T. Kay attempted to discover how the young, fat, ungainly bird, which is unable to fly, transforms itself into a powerful flier and slim expert diver capable of feeding itself (*British Birds*, 42, No. 9; September 1949). Kay's observations indicate that, after the young gannet has reached the sea, it is no longer fed by its parents and sustains itself for many days without food. Having developed its wings and lost its fat, it is able to get up first for short flights and then for longer ones until it is strong on the wing. Exactly how it secures its first meal is not known. Either it must dive on fish instinctively when alone or follow the example of older birds with which it is certain to come in contact. The conspicuous plumage of the older birds is probably of value to the young one in enabling it to pick out feeding birds at a distance. It would be interesting to read accounts of the young gannet's behaviour from observers who have witnessed any activity of the young bird in southern waters.

Health Education

THE Central Council for Health Education was formed in 1927 when a group of medical officers of health and other responsible men from local authorities met to consider what could be done in preventing as well as in curing illness. The report for 1948–49 describes what the Council achieved in its twenty-first year and what it plans to do in improving the nation's health. Under the National Health Service Act local authorities now have much wider opportunities for health education, and, on their behalf, the Council is hoping to develop its activities by providing them with more exhibition material and other visual aids. Believing that it can best help local authorities by arranging instruction for "natural health educators" rather than by large-scale propaganda aimed at the general public, the Council proposes to arrange more courses for health visitors, nurses, midwives, sanitary inspectors, food handlers and youth leaders. Among special activities undertaken by the Council during 1948–49 was the focusing of nation-wide attention on food hygiene and means of improving the national diet. During the coming year it is hoped to arrange certain health-education campaigns in industry.

Effect of Ultrasonics on Crystal Development

A PAPER by Franco A. Levi on the action of ultrasonics on the formation of metallic crystals through electrolytic deposits, which has recently appeared in *La Ricerca Scientifica* (Rome, August 1949), is devoted to a description, with two diagrams, of the apparatus utilized and the results obtained. The ultrasonics were generated in water by a piezo-electric crystal, and it was shown that these rendered the deposits less adhesive and in diminished quantity, and, in addition, altered the structure of the crystals that were formed. Such modifications could not, however, be observed when the ultrasonics acted *after* the formation of the crystals. The conclusion is that, while the conditions of the experiment in the first instance were favourable for the production of large crystals and a regular and extensive crystalline formation, the intervention of ultrasonics during the formation of the crystals disturbed the crystal growth and was responsible for a fine structure in the deposits.

Russian Periodicals: Translated Contents Lists

THE Department of Scientific and Industrial Research is issuing a series of "Translated Contents Lists" of Russian scientific and technical periodicals (see *Nature*, November 5, 1949, p. 777). This list is the outcome of the co-operation of several organisations; but most of the periodicals mentioned are available in the Science Museum Library, South Kensington, London, S.W.7. The Intelligence Section of the Department is prepared to assist in the location of a particular part of a periodical where difficulty arises, and it is stated that it may be possible to lend periodicals, of which translated contents lists are required, to organisations which are prepared to assist but do not themselves receive the periodicals. A recent number (No. 4; pp. 59; September 1949) covers the contents of twenty-three periodicals in such varied fields as biochemistry, electrical engineering, medicine, radio-technics, technical physics, chemistry, mathematics and surgery. The keeper of the Science Museum Library issues an invitation to all organisations preparing translations of Russian scientific and technical articles to forward one copy of each translation to the Science Museum Library. Translations accepted will be catalogued and listed in the list of accessions of the Library.

New Portuguese Medical Journal

THE first issue (pp. 104; August 1949) of the *Revista da Associaçao Médica de Minas Gerais*, published under the direction of Dr. Aulo Pinto Viegas, with the help of a distinguished group of Brazilian medical men, contains nine original articles, shorter contributions under the heading "De Rebus Pluribus", one book review and some abstracts of articles in other journals. Among the subjects discussed in the original articles in this first issue are the endocrine activity of the seminal epithelium, pulmonary tuberculosis as a complication of diabetes mellitus, red-cell sedimentation, cysts of the lung and the bacteriological diagnosis of the salmonelloses. All these are in the Portuguese language without summaries in English. A publication like this, which will give to the world the experience of South American medical men on a variety of subjects, cannot fail to be useful. Four numbers of the journal will be published each year, and correspondence should be addressed to Caixa Postal 260, Belo Horizonte, Minas Gerais, Brazil.

Chemisches Zentralblatt

AN announcement from Verlag Chemie, Weinheim and Berlin, states that the *Chemisches Zentralblatt*, which has been appearing in two parts, will as from January 1950 be published in its traditional form in one issue and will cover all chemical literature. This abstract journal was for many years the most complete of its kind, and gave more information than could usually be found elsewhere. It also abstracted more publications and dealt with aspects of chemistry not covered in other abstract journals until more recently. The new annual price will be DM. 250.

Automatic Control Mechanisms

DURING the Second World War great advances were made in the design and use of automatic control mechanisms for gunnery and radar, and now with the special requirements of new industrial processes, etc., a need is felt for some organisation devoted to encouraging progress in this subject. Engineering societies discuss some of its aspects on occasion; but the difficulty appears to be that the fundamentals of control are common to all branches of engineering and overflow into mathematics, physiology and psychology. On the initiative of certain members of the government inter-departmental Technical Committee on Servo-mechanisms, an attempt is now being made to bring together those who are interested in the scientific, technical and educational aspects. A sub-committee has been formed, and the Society of Instrument Technology has been approached with the view of forming a control section within the framework of the Society. This has been welcomed by the Society, and it is proposed that the section should cover the theory and practice of closed-loop control systems, including servo-mechanisms, regulators and process controllers, and also problems of the human operator as a controller and when part of a larger control system. An inaugural meeting will be held on March 28, at 6.30 for 7 p.m., at the Royal Society of Tropical Medicine and Hygiene, Manson House, Portland Place, London, W.1, when three

short papers will be read: Prof. K. A. Hayes, "Servomechanisms: Recent History and Basic Theory"; Dr. A. Utley, "The Problem of Stabilisation"; and Prof. A. Tustin, "Problems in Control Systems which await Solution". All who are interested in control mechanisms and allied subjects are invited to attend the inaugural meeting. If sufficient response is obtained, the inaugural meeting will be followed by a business meeting to deal with the formation of a control section of the Society of Instrument Technology.

International Conference on Spectroscopy at Radio-Frequencies

An International Conference on Spectroscopy at Radio-Frequencies will be held in Amsterdam during September 18–23. The Conference is being organised by the Netherlands Physical Society and supported by the International Union of Pure and Applied Physics. It is intended to have a number of introductory lectures on nuclear, paramagnetic and ferromagnetic resonance and on precision determination of atomic and molecular constants by radio-frequency methods, and these lectures will be followed by discussions. There will be other discussions at the sectional meetings. Further information can be obtained from the secretary of the organising committee, Prof. J. de Boer, Bunsenstraat 98, Amsterdam-O.

Conference on the Physics of Lubrication

A joint conference on the physics of lubrication has been organised by the Manchester and District Branch of the Institute of Physics and by the British Rheologists Club, and will be held in the Physics Department, University of Manchester, during June 29 (2 p.m.)–July 1 (noon). It is intended to devote sessions to fluid-film lubrication, boundary and extreme pressure lubrication and the physics of lubricants. Suggestions for papers will be welcomed and should be sent, as soon as possible, to the conference secretary, Mr. D. A. Crooks, Imperial Chemical Industries, Ltd., Dyestuffs Division, Hexagon House, Manchester.

Chemical Society: Annual Meeting

The annual general meeting of the Chemical Society will be held this year in the King's Buildings, University of Edinburgh, during March 29–30. The presidential address, by Sir Ian Heilbron, will be on "The Chemical Society—a Mid-Century Review", and Prof. G. Hevesy, who has been awarded the Faraday Medal of the Society, will give the Faraday Lecture, his subject being "The Application of Radioactive Indicators in Biochemical Studies". The anniversary meeting of the Royal Institute of Chemistry, to be held in Glasgow, follows on March 31 and April 1.

Royal Society Lectures for 1950

Royal Society Lectures for 1950 will be delivered as follows: Croonian Lecture, on June 15 by Prof. F. M. Burnet, director of the Walter and Eliza Hall Institute, Melbourne; Bakerian Lecture, on May 4 by Prof. P. W. Bridgman, Lyman Laboratory of Physics, Harvard University; Ferrier Lecture, on June 29 by Prof. J. Z. Young, professor of anatomy, University College, London; Wilkins Lecture, on December 14 by Prof. F. J. Cole, emeritus professor of zoology, University of Reading. The first Leeuwenhoek Lecture will be delivered on November 9 by Sir Paul Fildes, director of chemical bacteriology (Medical Research Council), Lister Institute, London; this Lecture was founded in 1948 by a bequest from Mr. George Gabb "for an annual lecture in the field of microbiology".

Seventeenth National Radio Exhibition at Birmingham

The Seventeenth National Radio Exhibition will be held at Castle Bromwich, Birmingham, during September 6–16. Since its inception in 1922, this Exhibition, which now includes television, has previously always been held in London (when at Olympia, it has been popularly called 'Radiolympia'), and the move to Birmingham this year is obviously connected with the recent opening of the television transmitter in that city. The Exhibition is being organised by the Radio Industry Council (at 59 Russell Square, London, W.C.1) on behalf of the British Radio Equipment Manufacturers' Association, and Mr. F. W. Perks is chairman of the organising committee, which is substantially the same as for the past two Exhibitions.

Postgraduate Scholarships in Agriculture

The Ministry of Agriculture and Fisheries and the Department of Agriculture for Scotland propose to award, for the academic year beginning October 1, or earlier, a limited number of postgraduate scholarships in agricultural economics, husbandry, statistics, and agricultural and dairy engineering. The closing date for applications is May 1. Further particulars can be obtained from the Secretary, Ministry of Agriculture and Fisheries (Research Branch), 1–4 Cambridge Terrace, Regent's Park, London, N.W.1, or the Secretary, Department of Agriculture for Scotland, St. Andrews House, Edinburgh, 1.

Announcements

Prof. E. N. da C. Andrade, director in the Royal Institution, has been elected *correspondant* for the Section of General Physics of the Paris Academy of Sciences.

The triennial award of the Coopers Hill War Memorial Prize and Medal, which fell in 1949 to the Institution of Electrical Engineers, has been made by the Council to Mr. E. D. Taylor, for his paper on "The Measurement of Inter-lamination Resistance on Varnish-Insulated Sheet Steel for Large Electrical Machines".

The Commonwealth Scientific and Industrial Research Organisation has decided to publish two new journals, the *Australian Journal of Agricultural Research* and the *Australian Journal of Applied Science*. These will appear quarterly, and it is expected that four issues of each journal will be published in 1950. Each journal will cost 30*s*. per annum, or 7*s*. 6*d*. per copy. The *Journal of the Council for Scientific and Industrial Research* ceased publication with Volume 21, No. 4 (November 1948).

Mr. J. W. Gruber, of the Department of Sociology, Temple University, Philadelphia, writes that he is collecting material referring to the life and work of the nineteenth-century British anatomist, St. George Jackson Mivart. Mr. Gruber will appreciate any information about Mivart, especially concerning unpublished correspondence.

INACTIVATION OF RIBONUCLEASE IN DILUTE AQUEOUS SOLUTIONS

Action of X-Rays

DALE[1] showed that enzymes in solution in water could be inactivated by irradiation with X-rays and that various other substances, in solution with them, could protect them from this destructive effect of irradiation. This work was, obviously, of the greatest importance to the biologist, as many easily oxidizable substances are present in considerable concentration in the cell and might exert a protective action on such cell enzymes or essential structures as are liable to destruction by the oxidizing radicals produced in irradiated water. Glutathione and ascorbic acid are two substances, normally present in the cell, which might be expected to act in this manner, and the following work was originally undertaken to test this possibility. The work of Barron[2,3], of Dale[4] and of Dale, Meredith and Gray[5] was not then published; but the experiments quoted here, undertaken independently, are in good agreement with the work of these authors.

Crystalline ribonuclease was very kindly supplied by Dr. Kunitz, of the Rockefeller Institute. This enzyme does not contain essential SH-groups and is therefore not reactivated by glutathione after irradiation (see table). Any effect of the glutathione in preserving enzyme activity is due to competitive action.

The enzyme was used in a concentration of $2{\cdot}5 \times 10^{-4}$ gm. per ml. The dose of X-rays used caused approximately 50 per cent inactivation of the enzyme. In any one experiment, the same enzyme solution was used throughout, and the estimations of activity carried out on the same substrate and incubated at the same time. Any variation in experimental conditions therefore affected the control and experimental samples equally.

It was found that a concentration of reduced glutathione equal to two-thirds by weight of that of the enzyme was usually enough to protect completely against the 50 per cent inactivation dose. Commercial samples of glutathione vary in purity, and therefore in effectiveness; but it was found that very little destruction of the enzyme occurred while sufficient glutathione was present to give a definite nitroprusside test for reduced glutathione at the end of the irradiation.

The accompanying table gives the results of these experiments. Oxidized glutathione undoubtedly also exerted protective action; but not enough experiments were carried out to determine whether or not it was actually as effective as reduced glutathione.

In view of the ready protection of the enzyme by glutathione, it seemed possible that the inactivation was caused by the formation of hydrogen peroxide in the irradiated water. The following experiments, however, gave no support to this possibility.

Barron[3] found that catalase protected other enzymes against inactivation by alpha-particles. Hydrogen peroxide was likely to be formed in considerable concentration during the irradiation of water by alpha-particles and would be broken down by the catalase. Catalase does not protect ribonuclease against inactivation by X-rays (see table). In order to avoid a general protective action by the protein of the catalase, the concentrations used were very small; addition of hydrogen peroxide at the end of the irradiation showed that it was still very active.

A negative result here is by no means conclusive proof of the non-participation of hydrogen peroxide in the destruction of the enzyme. Catalase can not only break down hydrogen peroxide, but can also have a peroxidase-like effect and cause oxidation of some substrates in the presence of hydrogen peroxide.

It is known that, in the absence of atmospheric oxygen, the amount of hydrogen peroxide formed by X-rays on pure water is very small indeed. Experiments were therefore carried out to decide whether the inactivation of ribonuclease was less in the absence of atmospheric air. The air was removed by evacuating a solution of enzyme in a vacuum tube;

ACTIVITY OF A GIVEN VOLUME OF ENZYME SOLUTION, BEFORE AND AFTER IRRADIATION

Results expressed as mgm. of soluble phosphorus liberated from 10 mgm. ribonucleic acid. Volume of enzyme and substrate made up to 1 c.c. in each test. Unchanged ribonucleic acid precipitated, after 10 min. incubation at pH 5·2, with uranyl acetate in trichloracetic acid. Precipitate discarded, soluble phosphorus estimated in filtrate. Dose of X-rays, 13,500 r. units.

Control 0·5 c.c. enzyme 0·07 0·25 c.c. enzyme 0·027	Irradiated 0·032 0·018	Irradiated + GSH 0·073 0·028	GSH added *after* irradiation 0·030 0·017	Concentration Enzyme 1 mgm. in 20 c.c. Glutathione 1 mgm. in 40 c.c.
Control 0·052	Irradiated 0·034	Irradiated + catalase 0·032		Concentration Enzyme 1 mgm. in 40 c.c. Catalase 1 mgm. in 160 c.c. Still very active at end.
Control 0·064 0·019	Irradiated in air 0·013 0·01	Irradiated *in vacuo* 0·019 0·00		Concentration Enzyme 1 mgm. in 40 c.c. Air removed by evacuation and absorption with pyrogallol. Air removed by freezing to − 195° C. and evacuation. All samples frozen.
		Enzymes exposed to H_2O_2		
Control 0·5 c.c. enzyme 0·049 0·25 c.c. enzyme 0·028	with H_2O_2 0·042 0·028	—	—	Concentration Enzyme 1 mgm. in 40 c.c. H_2O_2 *M*/20, for 30 min. in dark.
0·5 c.c. enzyme 0·035	0·038	—	—	The same.
0·5 c.c. enzyme 0·042 0·25 c.c. enzyme 0·026	0·040 0·026	—	—	Fresh sample of peroxide. *M*/100 for 25 min.

This table contains examples taken from a large number of experiments.

alkaline pyrogallol was present in a side bulb, and 30 min. was allowed between the evacuation of air and the irradiation, in order to allow of the absorption of any remaining traces of oxygen.

In the penultimate experiment quoted in the table, the air was removed by evacuation after freezing the solution at −195° by the method described in the following communication. The freezing caused some loss of enzyme activity; it was thus necessary to freeze both samples and to re-oxygenate one of them before irradiation. It can be seen that inactivation of the enzyme by X-rays did not depend upon the presence of oxygen.

These experiments suggested that the inactivation of the enzyme was not caused by hydrogen peroxide, and, finally, the effectiveness of added hydrogen peroxide in causing inactivation was tried. It was found that none of the concentrations used (M/1,000–M/20) had any appreciable effect on enzyme activity. An occasional slight loss of activity was seen, but this was not constant and did not increase with increasing concentrations of hydrogen peroxide. Precautions had to be taken to prevent sunlight from falling on solutions of enzyme containing hydrogen peroxide. The results are given in the table.

This insensitivity of the enzyme to hydrogen peroxide made it possible to carry out the experiments described in the following communication, in which the enzyme was dissolved in an M/100 solution of hydrogen peroxide and suffered no diminution of activity.

It should be pointed out that enzymes containing SH-groups are likely to be sensitive to hydrogen peroxide, and that this might therefore render them more sensitive to irradiation in conditions where the formation of hydrogen peroxide occurs. Barron's work[3] shows that catalase protects an SH-enzyme to some extent against irradiation by alpha-particles and, as he points out, this indicates that here part of the effect of the alpha-particles does depend on the formation of hydrogen peroxide.

The effect of X-rays on the chromosomes of living cells appears to be increased by the presence of oxygen. Thus Thoday and Reed[6] showed that bean roots irradiated in oxygen grew less and formed more chromosome bridges than those subjected to X-rays in nitrogen. Hayden and Smith[7] found that barley seeds irradiated in a vacuum showed a better germination and growth-rate, fewer mutations and less chromatinic bridge formation than those irradiated in air.

In these cases one may suppose that hydrogen peroxide, or radicals formed by the reaction of irradiated water and dissolved oxygen, are, at least in part, responsible for the effects produced by X-rays. In the case of ribonuclease and probably of other enzymes not containing essential SH-groups[4], there is no evidence that dissolved oxygen plays any essential part.

B. Holmes

Department of Radiotherapeutics,
Cambridge.
Aug. 8.

[1] Dale, W. M., *Biochem. J.*, **36**, 80 (1942).
[2] Barron, E. S. Guzman, Declassification Document 484, Lecture at University of San Marcos, "Effect of Radiation on Enzymes" (1946).
[3] Barron, E. S. Guzman, Dickman, S., and Singer, T. P., *Fed. Proc.*, **6**, 236 (1947).
[4] Dale, W. M., *Brit. J. Radiol.*, Supp. No. 1, 46 (1947).
[5] Dale, Gray and Meredith, *Phil. Trans. Roy. Soc.*, A, **242**, 33 (1949).
[6] Thoday, J. M., and Reed, J., *Nature*, **160**, 608 (1947).
[7] Hayden, B., and Smith, L., *Genetics*, **34**, 26 (1949).

Inactivation by Hydroxyl Radicals

The experiments described in the preceding communication indicate that the inactivation of ribonuclease in dilute aqueous solution by X-irradiation is due to the formation of some oxidizing entity which is not hydrogen peroxide. The possible species which might be concerned are the hydroxyl and hydroperoxide radicals (HO and HO_2). The hydroxyl radical is formed, together with atomic hydrogen, when any nuclear radiation is absorbed in water[1]. The hydroperoxide radical is produced by direct addition of molecular oxygen ($H + O_2 \rightarrow HO_2$) if this is also present in the water.

Since (*a*) it is possible to prepare hydroxyl radicals in water without nuclear radiations, (*b*) the ribonuclease is stable to dilute aqueous hydrogen peroxide (up to 0·05 M), and (*c*) we have developed successful methods for handling aqueous solutions under conditions of extreme deaeration, it was possible to carry out the following experiments to identify the inactivating agent.

(i) Hydroxyl radicals can be generated in aqueous media in a variety of ways[5], of which we have employed the following:

(*a*) $Fe^{+++}{}_{aq} + H_2O_{aq} + h\nu \rightarrow Fe^{++}{}_{aq} + H^{+}{}_{aq} + OH_{aq}$
(*b*) $H_2O_{2aq} + Fe^{++}{}_{aq} \rightarrow Fe^{+++}{}_{aq} + OH^{-}{}_{aq} + OH_{aq}$
(*c*) $H_2O_{2aq} + h\nu \rightarrow 2OH_{aq}$.

(*a*) An aqueous solution of ribonuclease containing $1{\cdot}25 \times 10^{-4}$ gm. per ml. was made 10^{-2} M in ferric alum (analytical reagent quality), to which it was stable. 10 ml. of this solution was thoroughly deaerated by repeated cooling (to −195° C. in liquid nitrogen) and evacuation. Since such treatment was found to result in some loss of enzyme activity, two cylindrical 'Pyrex' glass cells were attached to the bulb in which the freezing was performed. After deaeration, the solution was divided between the cells by rotating the whole system about a ground-glass joint. The two samples were sealed off under vacuum in their respective cells. One of them was immersed in a thermostat provided with quartz windows and illuminated with light from a hot mercury arc for 30 min. The other was kept in darkness in the same thermostat for the same time. Two control samples were treated in exactly the same way except that the ferric alum was absent. In the former case, complete inactivation of the enzyme occurred; in the latter, the inactivation was negligible. Since 'Pyrex' glass cuts off effectively at about 3000 A. and in the solutions used about 90 per cent of light of this wave-length would be absorbed by the ferric salt[3] and only about 3 per cent by the enzyme[4], inactivation in this case can only be attributed to hydroxyl formed in reaction (*a*)*.

(*b*) The experiments with oxygenated and deoxygenated solutions described in the previous communication indicated that the degree of inactivation by X-rays is independent of the presence of oxygen. This indicates that either hydroperoxide radicals are ineffective in destroying the activity, or the enzyme competes successfully with oxygen for hydrogen and no hydroperoxide is formed. The former seems the more likely; but, whatever the reason, exhaustive deaeration is unnecessary and was not, therefore, carried out in the experiments described in this and the following sections.

* In view of the work of Evans and Uri, *Nature*, **164**, 404 (1949), reaction (*a*) should be written:

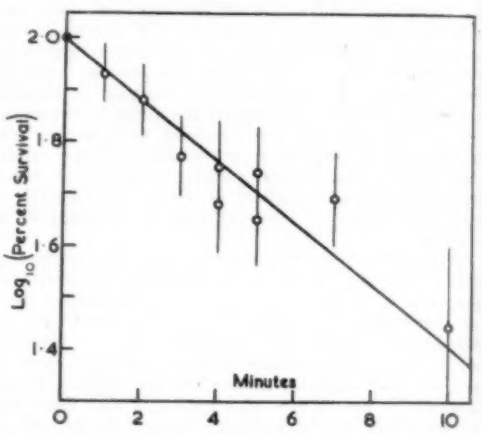
$$Fe^{3+}.OH^{-}_{aq} + h\nu \rightarrow Fe^{2+}_{aq} + OH_{aq}.$$

An aqueous solution of ribonuclease containing $1{\cdot}25 \times 10^{-4}$ gm. per ml. was made 10^{-4} *M* in ferrous sulphate and 10^{-3} *M* in hydrogen peroxide. Control samples were also taken consisting of enzyme in the same concentration together with 10^{-3} *M* hydrogen peroxide and 10^{-3} *M* ferrous sulphate separately. Each solution was allowed to stand for half an hour after preparation before the enzyme activity was assayed.

The ferrous sulphate alone had no effect. The hydrogen peroxide alone produced a negligible decrease of activity; but the combination of ferrous sulphate and hydrogen peroxide brought about complete inactivation of the enzyme during this time. This again indicated that the hydroxyl radical is the entity producing inactivation of the enzyme.

(*c*) In media containing hydrogen peroxide, hydroxyl radicals initiate a chain reaction resulting in destruction of the peroxide and the formation of oxygen gas. When these radicals are formed photochemically according to reaction (*c*), the chain carriers are hydroxyl and hydroperoxide radicals, and any solute which inhibits oxygen evolution from the photochemical decomposition must, provided it is not acting as an inner filter for the light, be reacting with hydroxyl or hydroperoxide or both. In preliminary experiments it was shown that 2·5 mgm. enzyme in 10 ml. of 0·0118 *M* hydrogen peroxide, contained in the reaction vessel of an apparatus constructed for measuring and collecting evolved oxygen from aqueous hydrogen peroxide undergoing photochemical decomposition, evolved no oxygen when illuminated with a hot mercury arc, under conditions where the enzyme-free solution did liberate oxygen. This result, together with those of (*a*) and (*b*) and the previous communication, was taken to confirm the inactivation of this enzyme by the hydroxyl radical.

(ii) In order to discover whether the hydroxyl radicals also react with the inactivated enzyme, it was decided to construct a survival-dose curve[5] under conditions of constant rate of production of hydroxyl radicals. This was achieved as follows. A very small quantity of a solution of hydrogen peroxide, the strength of which was known accurately, was weighed into a flask. The solution was a commercial sample which had been re-distilled under vacuum in a 'Pyrex' apparatus and was about 30 per cent hydrogen peroxide. A requisite amount of a solution of enzyme containing $1{\cdot}25 \times 10^{-4}$ mgm. per ml. to give a concentration of hydrogen peroxide of 10^{-3} *M* was added, the exact concentration being obtained by weighing the solution. Of this solution 10 ml. was pipetted into a cylindrical quartz cell 1 cm. deep and 5 cm. in diameter, having plane ends and two entrance tubes. The cell was fixed by a ground-joint in a given position in a thermostat at 25° C., and the cell contents were irradiated, under constant conditions, by light from a cold mercury lamp of the rare-gas type. The remaining solution was placed in a darkened tube which was hung in the same thermostat for the same period of time as the cell and served as a control. Two other controls were also taken, using another portion of the same enzyme solution. 10 ml. of the enzyme solution alone was put into the cell and irradiated by the lamp, and a sample of enzyme solution in a darkened tube was placed in the thermostat, both for the same time as in the previous case. Assay of the enzyme activity of each solution was carried out as soon as possible after the irradiations were completed. In nearly all the experiments, four such solution analyses were obtained, though in the later ones the control using hydrogen peroxide in the dark was omitted, as it was always found that the reduction in activity produced by it was negligible. The times of irradiation were varied between 0 and 20 min., complete inactivation being obtained in the case of hydrogen peroxide and light after about 10 min. In all cases, at least two assays of enzyme activity were carried out, the percentage inactivation being estimated from the ratio of the volume of control enzyme solution to the volume of irradiated solution required to give the same yield of soluble phosphorus. The lamp gave radiation of wavelength 2537 A. almost exclusively, the reason for this choice of wave-length being that the difference in absorption coefficient of the enzyme and hydrogen peroxide is greatest in this region, ribonuclease having a minimum of absorption at 2520 A.[4].



From the results of these experiments, it was at once possible to plot two curves, one showing the inactivation produced by ultra-violet light alone and the other the inactivation due to hydrogen peroxide and ultra-violet light. Subtraction of the former from the latter led to a curve showing the inactivation due to hydroxyl radicals alone. Slight corrections were made to the points on this curve to allow for the small differences in concentration of hydrogen peroxide in the different experiments, the corrections being based on the values of the absorption for different concentrations of hydrogen peroxide. A plot of log (per cent inactivation) against time yielded a straight line, as shown in the accompanying graph. It was found also that irradiation of a solution of 10^{-3} *M* hydrogen peroxide alone produced 50 per cent decomposition only after a period of 2 hr. It can, therefore, be assumed that over the period of irradiation considered, the concentration of the hydrogen peroxide is effectively constant. Hence the results show conclusively that the inactivated enzyme competes effectively with the active enzyme for hydroxyl radicals.

The relevance of these experiments to the effects produced by absorption of nuclear radiations in living tissue is that they indicate that some of these effects, but not necessarily all, may be due to the action of free radicals or atoms formed from water, where this is the principal component. In the special case of ribonuclease, enzyme activity is destroyed by hydroxyl radicals.

We are indebted to Dr. Kunitz for the enzyme and to the Department of Scientific and Industrial Research for financial aid.

E. Collinson
F. S. Dainton
Laboratory of Physical Chemistry,
B. Holmes
Department of Radiotherapeutics,
University, Cambridge.

[1] For a discussion of the action of nuclear radiations on water, see Dainton, F. S., *Ann. Rep. Chem. Soc.*, **45**, 5 (1948).
[2] For bibliography, see ref. 1.
[3] Rabinowitch and Stockmayer, *J. Amer. Chem. Soc.*, **64**, 335 (1942).
[4] Uber and Ells, *J. Biol. Chem.*, **141**, 229 (1941).
[5] Cf. Dale, Meredith and Tweedie, *Nature*, **151**, 281 (1943).

NON-LOCALIZABLE FIELDS AND RECIPROCITY

THE purpose of the following note is to direct the attention of physicists to a short paper by H. Yukawa[1] which has recently appeared. It seems to me to contain a most important advance in the theory of elementary particles, based on an extremely simple idea.

Yukawa uses two principles which I have suggested at different times but failed to combine, namely: (1) the principle of non-localizability of fields[2] (as Yukawa calls it), which rejects the introduction of co-ordinates and time as independent parameters on which the field operators depend, but proposes to treat co-ordinates and time as observables, represented by operators, and to characterize the space-time dependence of the field quantities by commutation rules; (2) the principle of reciprocity[3], according to which the fundamental equations of physics are symmetrical in space-time and momentum-energy.

The non-localizability of fields is formulated by replacing the derivative $\partial f/\partial x^\mu$ of a field variable f by the commutator $i\hbar^{-1}[p_\mu, f]$, where x^μ are co-ordinates and time, p_μ the corresponding components of momentum and energy, while f is an abstract observable (operator), not a function of the x^μ. However, Peng and I have shown that this apparent generalization alone leads no further than the ordinary theory, since in the representation where the x^μ are diagonal the equations reduce to the usual formalism of field theories.

Concerning reciprocity, it must be admitted that if there is any symmetry of space-time and momentum-energy in Nature, it is not obvious at all in the motions of particles; this objection has been raised again and again in discussions when I tried to explain my ideas. These were actually based on the conviction that a symmetry appearing in the most fundamental law of quantum theory, the commutation rule

$$[x^\mu, p_\nu] = i\hbar\delta_\nu{}^\mu, \qquad (1)$$

cannot be accidental, but must correspond to a general invariance principle. Although this is a rather formal argument, it seems to me very powerful if one remembers how fundamental laws of physics have been actually found (relativity, de Broglie waves, positron, meson, etc.). Therefore, Green and I made a new attempt to use the reciprocity principle, by applying it not to the wave functions ψ, which describe the motion of particles, but to the wave operators $F(p)$, which determine the wave equations of free particles, $F(p)\psi(x) = 0$. In this way it is possible to understand the existence of different particles, and to obtain numerical values for their rest-masses. I think that this point of view is of importance.

But now Yukawa has shown that the symmetry, about which there was considerable doubt, in x^μ and p_μ for the wave functions themselves has a perfectly definite and clear meaning, provided the principle of reciprocity is combined with the non-localizability of fields. I will indicate his reasoning.

Starting from an ordinary wave equation $\Box U - \varkappa^2 U = 0$ for a scalar wave function U he obtains, by substituting commutators for the derivatives,

$$[p_\mu, [p^\mu, U]] + m^2c^2U = 0, \quad \frac{mc}{\hbar} = \varkappa, \qquad (2)$$

and he supplements this by the reciprocal equation

$$[x_\mu, [x^\mu, U]] - \lambda^2 U = 0, \qquad (3)$$

where λ is a length. Moreover, he adds a third equation which, roughly speaking, expresses the fact that if x^μ is a space-like 4-vector, p_μ is time-like, namely,

$$[p_\mu, [x^\mu, U]] = 0. \qquad (4)$$

The field operator U can be expressed, in the representation where the x^μ are diagonal, as a matrix $U(x', x'')$, where x' and x'' stand for the four components. Then the matrix elements of $x_\mu U$ and Ux^μ are $x_\mu{}'U(x', x'')$ and $x_\mu{}''U(x', x'')$, respectively, while those of $p_\mu U$ and Up_μ are $-i\hbar\dfrac{\partial}{\partial x^{\mu'}}U(x', x'')$ and $i\hbar\dfrac{\partial}{\partial x^{\mu''}}U(x', x'')$, respectively. This follows from the matrix representation of x_μ and p_μ with the help of δ-functions, namely,

$$x_\mu{}'\delta(x_\mu{}' - x_\mu{}'') \text{ and } -i\hbar\,\delta'(x_\mu{}' - x_\mu{}''),$$

respectively, by performing the matrix multiplication.

Hence the matrix element of the commutator $[x_\mu, U]$ is $(x_\mu{}' - x_\mu{}'')\,U(x', x'')$, but that of $[p^\mu, U]$ is $-i\hbar\left(\dfrac{\partial}{\partial x_\mu{}'} + \dfrac{\partial}{\partial x_\mu{}''}\right)U(x', x'')$.

The difference in sign on the right-hand side is the point of Yukawa's remark. It suggests the introduction of the new variables

$$X_\mu = \tfrac{1}{2}(x_\mu{}' + x_\mu{}''), \quad r_\mu = x_\mu{}' - x_\mu{}'', \qquad (5)$$

and $U(x', x'')$ is regarded as a function of these, $U(X_\mu, r_\mu)$. Then the matrix elements of the two commutators $[x_\mu, U]$ and $[p^\mu, U]$ mean simply multiplication by r_μ and differentiation with respect to X_μ of the function $U(X_\mu, r_\mu)$; hence the equations (2), (3), (4) become

$$\left(\frac{\partial^2}{\partial X_\mu \partial X^\mu} - \varkappa^2\right)U = 0, \quad \varkappa = \frac{mc}{\hbar} \qquad (2')$$

$$(r_\mu r^\mu - \lambda^2)\,U = 0, \qquad (3')$$

$$r^\mu \frac{\partial U}{\partial X^\mu} = 0. \qquad (4')$$

Yukawa shows that these equations have a solution which can be written down as a superposition of waves in the X_μ- and r_μ-spaces (8-dimensional Fourier integral). But the significance of the formulæ (2'), (3'), (4') can be seen without the explicit solution.

There are two sets of variables and corresponding equations for the description of the motion of the particle. One set, X_μ, refers obviously to the motion of the whole; it represents in a certain way the centre. The other set, r_μ, refers to the internal

structure. If the dependence of U on the X_μ is given by a factor $\exp(ik^\mu X_\mu)$, (2′) and (4′) reduce to

$$k_\mu k^\mu + \varkappa^2 = 0, \quad r_\mu k^\mu = 0. \qquad (6)$$

Hence for a particle at rest ($k_1 = k_2 = k_3 = 0$, $k_4 = \pm \varkappa$) one has $r_4 = 0$ and (3′) reduces to

$$(r_1^2 + r_2^2 + r_3^2 - \lambda^2)U = 0,$$

which shows that λ is the 'radius' of the particle.

Yukawa has generalized these considerations to particles with spin and sketched the procedure for field quantization.

The essential point seems to me the demonstration that it is perfectly legitimate to postulate the simultaneous validity of both reciprocal wave equations in x-space and p-space for non-localized fields because, by the nature of the commutators, they split automatically into two sets, one referring to the internal structure, the other to the resultant motion. This idea is so elementary and simple that I expect important results from further development.

M. Born

[1] Yukawa, H., *Phys. Rev.*, **76**, 300 (1949); see also *Prog. Theor. Phys.*, **2**, 209 (1947); **3**, 205, 452 (1948).

[2] Born, M., and Peng, H. W., *Proc. Roy. Soc., Edin.*, A, **62**, 40, 92, 127 (1944). The idea of non-localizable fields was also proposed by Markow, *J. Phys.*, **2**, 453 (1940).

[3] Born, M., *Proc. Roy. Soc.*, A, **165**, 291 (1938); **166**, 552 (1938); *Proc. Roy. Soc. Edin.*, **59**, 219 (1939).

Landé, A., *Phys. Rev.*, **58**, 482 (1939).

Born, M., and Fuchs, K., *Proc. Roy. Soc., Edin.*, **60**, 100, 141 (1940).

Fuchs, K., *id.*, **60**, 147 (1940); **61**, 26 (1941).

Sarginson, E., *id.*, **61**, 77 (1941).

Born, M., *Nature*, **163**, 207 (1949).

Born, M., and Green, H. S., *Nature*, **163**, 208 (1949).

Bora, M., and Rodrigues, A. E., *Nature*, **163**, 320 (1949).

Cheng, K. C., and Rodriguez, A. E., *Nature*, **163**, 367 (1949).

Born, M., and Green, H. S., *Proc. Roy. Soc., Edin.*, A, **62**, 470 (1949).

Born, M., *Rev. Mod. Phys.*, **21**, 463 (1949).

Born, M., Cheng, K. C., and Green, H. S., *Nature*, **164**, 281 (1949).

SIXTH (U.S.S.R.) CONGRESS ON HIGH-MOLECULAR COMPOUNDS

An account of a Soviet conference, the Sixth Congress on High-molecular Compounds, which was held in Leningrad in June 1949, has recently been published (N. Mikhailov, *Kolloidnyĭ Zh.* (in Russian), 11, (6), 444; 1949). The Congress discussed the physics and chemistry of natural and synthetic high-molecular compounds. Thirty-two papers were given under the following headings: (1) mechanical and kinetic properties of high-molecular compounds; (2) physico-chemical properties and methods of research; (3) structure and methods of research; (4) the mechanics of high-molecular substances.

About a third of the papers given were concerned with mechanical and kinetic properties, including contributions by Kh. S. Bagdasar'yan, S. S. Medvedev and co-workers, P. M. Khomyakovskiĭ, V. V. Korshak and co-workers, M. F. Shostakovskiĭ and S. Ē. Bresler. There was considerable discussion on questions of nomenclature, following the paper by V. V. Korshak. A special committee, composed of the leading chemists in synthetic high polymers, was appointed to prepare the ground for further conferences. A discussion on the kinetics and mechanics of vulcanized rubber was introduced by B. A. Dogadkin. Many new researches were described which will help to further knowledge of the theory of the process of vulcanization.

In the second section the principal speakers were N. I. Nikitin, S. N. Oshakov, the late I. I. Zhukov, P. P. Kobeko, V. I. Ivanov, A. G. Pasynskiĭ and Z. A. Rogovin. The importance of molecular weight determinations was stressed and the various experimental methods were discussed. Problems of molecular structure were considered in relation to methods of research based on the Marxist–Leninist principles of Soviet science.

In the third and fourth sections, the principal speakers were V. A. Kargin, B. A. Dogadkin, N. V. Mikhailov, S. I. Sokolov and G. B. Bartenev. A new method for studying the properties of high-polymer films and solutions on metal surfaces—'the blow-off method'—was described by B. V. Deryagin and N. N. Zakhovaev.

More than a hundred and fifty delegates attended the Congress as well as many guests. Plans were made for the Seventh Congress to be held at the end of 1950 with, for its programme, general questions on the physics and chemistry of high-molecular compounds and the methods of their investigation.

G. W S. B.

INDEPENDENCE OF FUNDAMENTAL RESEARCH

An address on "Government Research as an Aid to Secondary Industry", given by Dr. I. W. Wark last August and now published in the *Journal of the New Zealand Institute of Chemistry* (October 1949), is of some general interest, less for the account of the way in which the Division of Industrial Chemistry of the Commonwealth Scientific and Industrial Research Organisation is helping secondary industry, with which Dr. Wark concludes his lecture, than for some of his observations on academic research and conditions of service. Much of what Dr. Wark said about the help given by his Division to the foundry and fell-mongering industries, to wool research, the development of alkaloids from indigenous plants, etc., can be gleaned from the annual reports issued by the Organisation; but his observations on the growth of industrially sponsored work within the universities and leading institutes of technology will be widely welcomed. He recognizes that some such work may be necessary, but strongly opposes a drift from the free research of the endowed university to the controlled research of the dependent university.

Dr. Wark recognizes the danger that the universities may also lose some of their independence if they accept contracts for secret defence research, and he points out that while it may be expedient to sacrifice minor freedoms to preserve the major, it is not easy to call a halt or to draw the line once the process starts. He comments on the different form which the organisation of industrial research has taken in the United States and in Great Britain. While the newer industries have always depended largely on research, the traditional industries also owe their existence to research, though of a far less formal type, and Dr. Wark suggests that one reason why such a country as the United States has not produced more leaders in research is the failure to realize generally that methods adapted to promote efficiency in production are unsuitable when applied to research. He appears to regard the research association of Great Britain as a more satisfactory institution than the research foundation system of the United States, though he recognizes that both

systems have their points and that it is unwise to copy either too rigidly or exclusively in other countries, particularly in those such as Australia and New Zealand, with small populations, in which government institutions such as his own Division of Industrial Chemistry may have to shoulder for many years to come wider responsibilities than their counterparts in Britain.

Dr. Wark's comments on the creation of the research associations are interesting. While he approves their creation close to the industries they serve, he suggests they would be doing better work if located in groups or in proximity to the universities. He believes that applied research only flourishes and continues to flourish when prosecuted in proximity to related fundamental work. After a quick glance at conditions in Europe, Dr. Wark points out that for years to come Australia must accept more than she gives in the field of research. Her universities are not developed to the same extent as those of Europe and America and must be built up both to do more research and to train more persons in research methods. They are more dependent on government aid, and Dr. Wark hopes that the Commonwealth Government will be as far-sighted as that of Great Britain and not attempt to curtail liberties in making its grants to the universities. Again, while Australian graduates go overseas for experience in research, those with an interest in fundamental work tend to remain overseas, and the flow in the reverse direction does not yet balance this very serious loss. Moreover, it will not be sufficient to strengthen Australian laboratories unless adequate subsidiary services such as workshops and libraries are provided, and unless the demands for immediate practical results from all research work are stopped. The research worker must be allowed to attack practical objectives on a sufficiently fundamental plane, and the human aspect must also be recognized. Dr. Wark says frankly that frustrations arising from regulations that are useful in other types of work have ruined completely the morale of half the government laboratories of the world.

THE MATHEMATICAL ASSOCIATION

ANNUAL MEETING

THE annual meeting of the Mathematical Association was held at the Regent Street Polytechnic, London, during January 3–4. For his presidential address, Sir Harold Spencer Jones, the Astronomer-Royal, spoke on "The Measurement of Time", describing the search for increasingly accurate methods of time determination, from the earlier transit instruments to the ingenious Shortt clock, with its correlated 'free' and 'slave' pendulums, and the recently devised quartz crystal clock, a timekeeper the accuracy of which is surprising.

On the afternoon of January 3, a discussion on "Mechanics in Schools" was opened by Mr. K. S. Snell (Harrow School) and Dr. E. A. Baggott (Regent Street Polytechnic). Should statics precede dynamics? Should the novice begin with absolute or with gravitational units? What is the place of experimental work in the school course, and what degree of correlation with the physics laboratory is desirable? These questions raised a vigorous open debate, since on none of them was unanimity exhibited.

A paper from Prof. H. S. W. Massey, on "The Method of Mathematical Physics", described the four stages of investigation—the collection and classification of data, the grand inductive hypothesis, and the deductive predictions therefrom, and the experimental verification of these last two stages so as to provide a demonstration of the validity of the induction. Examples of this sequence were given, particularly with reference to fundamental problems in nuclear physics.

On the second day, the meeting began with a paper by Dr. Frank Smithies on "Abstract Analysis". The fundamental concept of the limit in mathematical analysis was successively generalized from the simplest form, familiar to beginners in the calculus, up to the highly abstract notion of a limit in a general topological space, depending on the work of H. Cartan on 'filters' and of E. H. Moore on 'directed sets'. This was followed by an account of "Automatic Calculating Machines" by Prof. D. R. Hartree, in which the recent great development in automatic calculators was illustrated from his wide experience of such machines, particularly the Harvard Mark 1 machine and the electronic delay storage automatic calculator (EDSAC), constructed at the Mathematical Laboratory in Cambridge by Dr. M. V. Wilkes, which is now in operation. Prof. Hartree paid tribute to the great but half-forgotten pioneer work of Charles Babbage (1792–1871); he also deprecated the use of the name 'electronic brain', since these machines "can only do what we know how to order them to perform".

The afternoon of January 4 was occupied with a discussion on "Mathematics in the Comprehensive School", opened by Mr. F. J. Swan and Miss Y. Guiseppi, both of West Norwood County Secondary School. Mr. Swan spoke of the general problems of mathematical teaching in a large Comprehensive School, and Miss Guiseppi described in detail various teaching methods she has designed to give children in the Comprehensive School the mathematics they need in a stimulating form. In the general discussion, it was evident that members of the Association are anxious to protest against the view sometimes held by parents that the Comprehensive School is a 'poor relation' of the Grammar School; they are also deeply concerned with the problem of helping the teacher who may have to teach a good deal of mathematics in such a school but is not a mathematical specialist. Such a teacher cannot afford to join the teaching associations of all the subjects he may be called on to teach; nevertheless, these associations must regard the helping of these teachers as one of the most urgent of their present-day problems.

The final paper, "A Theory of Measurement", by Prof. Herbert Dingle, discussed an interesting philosophical problem. The theory of relativity necessitates some change in the view that a measurement determines the magnitude of some intrinsic property of a body, and Prof. Dingle propounded a definition, developed from a suggestion due to P. W. Bridgman, that a measurement is simply a specifiable operation leading to a number. After exhibiting the ambiguities to which the older view can lead, the speaker showed how the new definition can be used to clarify some points in probability and in quantum theory.

The Association elected Prof. H. R. Hassé, formerly H. O. Wills professor of mathematics in the University of Bristol, as president for the forthcoming year.

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

An Electron-Microscopic Investigation of the Cell-wall Organisation of Conifer Tracheids

In the past, considerable controversy has centred upon the interpretation of the observed optical heterogeneity of the secondary-cell walls of conifer tracheids when viewed between crossed Nicol prisms[1–4]. More recent optical observations[5,6], however, have shown the walls of these cells to be composed of three coaxial micellar spirals such that the outer and inner spirals are relatively flat and appear bright between crossed Nicols, while the central spiral is steep and appears dark between crossed Nicols.

To obtain direct evidence using the electron microscope, in support of the above conception of cell-wall organisation in conifer tracheids, it is sufficient that the micellar orientation in either the outer or inner layer should be established, since the existence of a steep micellar spiral in the central layer has been demonstrated by optical[1,4,7] and X-ray evidence[1,2,5]. In the present investigation, the micellar orientation of the cellulose was established for the inner layer of the secondary wall of tracheids of *Pseudotsuga taxifolia*. This was done by preparing 'Formvar' replicas of gold-shadowed tangential longitudinal sections of the wood. The inner surface of the tracheids and the orientation of the specimens were recognized from the spiral cell-wall thickenings of the tracheids, which in the specimens used were inclined at 60° to the longitudinal cell axis.

A micrograph obtained in the above manner is shown in Fig. 1, where the inner layer of the secondary wall can be recognized between the white bands which correspond to the spiral cell-wall thickenings. From this micrograph it is apparent that cellulose fibrils of the inner layer are inclined at approximately 80° to the longitudinal tracheid axis in the specimen used. This observation would thus confirm the type of cell-wall organisation described above.

Fig. 1. *Pseudotsuga taxifolia*. Showing striation direction in the inner layer of the secondary wall, which is visible between the spiral thickenings appearing here as diagonal bands across the photograph

Fig. 2. *Pseudotsuga taxifolia*. Portion of the secondary-cell wall showing parallel orientation of cellulose fibrils 50–100 A. in diameter

In Fig. 1 the fibrillar nature of the cellulose is distinguishable only with difficulty, since it is masked by lignin and other encrusting substances. To investigate this fibrillar structure of cellulose further, delignified sections were disintegrated in a Waring blendor[8] and were examined directly after shadowing with uranium. In photographs of some specimens obtained in this way a uniform fibrillar orientation was observed (Fig. 2), while in others a crossed fibrillar organisation was observed in which the fibrils crossed at an angle of approximately 70°. As yet, however, it has not been possible to establish with any certainty to which cell-wall layer each of these types of organisation belongs.

In many specimens of wood examined (see Fig. 2), as well as in the cell walls of cambium, the fibrils have been found to be 50–100 A. in diameter, which would seem to be in fair agreement with the X-ray estimate of 50–60 A. as the diameter of the micelles[9]. It would thus seem that fibrils such as those in Fig. 2 correspond to the micelles deduced as existing in cell walls on the basis of optical and X-ray evidence. However, in view of the apparently indefinite length of the fibrils (Fig. 2), the present observations, in agreement with those of Preston *et al.*[10], would appear to be more consistent with the concept of the micelle as proposed by Meyer[11] than with the 'fringed micelle' hypotheses[12,13]. It is of interest that the fibrils observed during the present investigation are considerably narrower than those observed by other investigators[9,10].

At high magnification the fibrils (Fig. 2) gave the impression of consisting of a series of small particles

50–100 A. in diameter, placed end to end. This observation was made previously by Farrant[14], and has since been described by other workers[10,15]. If this appearance of the fibrils does reflect an intrinsic feature of their organisation, the possibility of a smaller unit of aggregation would seem to exist.

The above investigations form part of the research programme of the Division of Forest Products and the Division of Industrial Chemistry, Commonwealth Scientific and Industrial Research Organisation, Melbourne. A full account will be given in a later publication.

A. J. Hodge

Division of Industrial Chemistry,

A. B. Wardrop

Division of Forest Products,
Commonwealth Scientific and
Industrial Research Organisation,
Melbourne.
Oct. 3.

[1] Preston, R. D., *Phil. Trans.*, B, **234**, 131 (1934).
[2] Kerr, T., and Bailey, I. W., *J. Arnold Arb.*, **15**, 327 (1934).
[3] Bailey, I. W., and Berkley, E. E., *Amer. J. Bot.*, **29**, 231 (1942).
[4] Preston, R. D., *Proc. Roy. Soc.*, B, **133**, 327 (1946).
[5] Wardrop, A. B., and Preston, R. D., *Nature*, **160**, 911 (1947).
[6] Wardrop, A. B., and Preston, R. D. (in the press).
[7] Bailey, I. W., and Vestal, M. R., *J. Arnold Arb.*, **18**, 185 (1937).
[8] Frey-Wyssling, A., Muhlethaler, K., and Wyckoff, R. W. G., *Experientia*, iv/12, 478 (1948).
[9] Hengstenberg, J., and Mark, H., *Z. Krist.*, **69**, 271 (1928).
[10] Preston, R. D., Nicolai, E., Reed, R., and Millard, A., *Nature*, **162**, 665 (1948).
[11] Meyer, K. H., "Natural and Synthetic High Polymers" (Interscience Publishers, New York, 1942).
[12] Astbury, *Trans. Farad. Soc.*, **29**, 193 (1933).
[13] Frey-Wyssling, A., *Protoplasma*, **25**, 261 (1936).
[14] Farrant, J. L., A.N.Z.A.A.S. Conference, Perth, 1947.
[15] Kinsinger, W. G., and Hock, C. W., *J. Indust. Eng. Chem.*, **40**, 1711 (1948).

A Simple Replica Technique Suitable for the Study of Surface Structures

In the course of some investigations on the minute cuticular hairs of certain insects[1], a replica technique was devised which, by virtue of its simplicity, may be of general interest. The medium of which these replicas were formed was a strong solution of glycerine in gelatin, obtained by steeping powdered gelatin in glycerine for some hours at 50–60° C. until homogeneous. The strength found to be most effective was about 50 per cent w/w; but the exact amounts to be employed are probably best determined by trial, since the nature of the sample of gelatin used probably has an effect. A very small quantity of water added to the mixture was found to hasten and improve the homogenizing process; but too much water should be avoided as it appears to reduce the quality of the replicas by rendering them too soft and plastic. The solution should normally be of such strength as to gelate at about 40–50° C., and set instantaneously below 30° C.; when in use it is conveniently kept liquid by means of a hot-water bath.

In order to make a replica a small quantity of the medium is smeared on a microscope slide kept hot by resting it on a beaker of boiling water. The slide is then removed and the insect placed upon it, touching the gelatin medium at the required orientation while the latter is still molten; the slide is then inverted and dowsed in cold water on the reverse side to set the medium. After 15–30 min. the insect can be removed, leaving a perfect replica of its cuticle in the now hardened medium which is readily examined under the microscope. These replicas do not normally require to be spattered or shadowed to show up the surface relief, but can be examined by transmitted, slightly oblique or dark-ground illumination. They do not shrink and last for several days, since the glycerine is non-volatile; but they should not be squeezed or distorted, as this causes them to lose fine detail.

The great merit of the medium is its elasticity and low adhesion to organic structures, so that neither it nor the specimen is torn or damaged on separation. Even very long, thin hairs which penetrate considerably into the medium come out whole, and leave elongated holes in the replica which can be followed in optical section when examined under the microscope. Hairs which are lying actually at the interface separating the medium from the insect are to be seen in the replicas as hollows or streaks, while parts of the cuticle devoid of or sparsely covered by hairs reveal clearly a pavement-like mosaic probably representing the domains of the hypodermal cells below.

In general, it is found to be much easier to appreciate the shapes of surface structures by making a replica of this kind (remembering, of course, that the replica is inverse) than by examination under vertical or oblique illumination, because the latter method not only produces much scattered and diffracted light but also picks out reflecting or refrangible granules which confuse the overall effect of the surface contour.

D. J. Crisp
W. H. Thorpe

Department of Zoology,
University,
Cambridge.
Oct. 11.

[1] Thorpe, W. H., and Crisp, D. J., *J. Exp. Biol.* (in the press).

Mass Measurements on Fast Particles Ejected from Cosmic Ray Stars

During the careful investigation of 118 nuclear disintegrations obtained in Kodak *N.T.*4 emulsions, exposed to cosmic rays at the Jungfraujoch (3,650 m.), the identification of particles producing long tracks was attempted.

The plates were calibrated by grain-counting on twelve long tracks formed by light (215 m_e) mesons, identified as such by the decay electrons produced when they came to rest in the emulsion. We thus obtained an experimental curve dN/dR versus R/m, where dN/dR is the grain density (number of grains per 70 μ), R the residual range in microns of the particle of rest mass mc^2 and velocity $c\beta$. From a theoretical R/m versus β curve we could thus construct the curve dN/dR versus β.

If a track has sufficient length in the emulsion, we can determine the mass of the particle that produced it by two independent methods. First, we may determine the difference in grain-density between the ends of the track and see whether such a difference is expected for a meson (π) or a proton track. Secondly, measurement of the small-angle Coulomb scattering determines the quantity $P\beta$ (momentum $\times$ velocity), and, obtaining the velocity from grain-density measurements at the beginning of the track, we can determine the mass of the particle. Scattering

Track No.	Initial grain-density	Initial β	Length of track in emulsion (μ)	Expected grain-density at end of track		Observed grain-density at end of track	Mass estimated from scattering measurements	Inference
				(*a*) Proton	(*b*) π-Meson			
1	58 ± 6	0·300	800	53 – 66	62–200	62 ± 6	—	Indefinite
2	45 ± 4	0·389	2400	42 – 51	~200 range only	41 ± 3	800 m_e	Proton
3	56 ± 3	0·312	3600	58 – 66	~1300 μ range only	63 ± 3	—	Proton
4	69 ± 4	0·247	2700	83 –150	700 μ range only	74 ± 3	—	Proton
5	53 ± 3	0·335	3000	55 – 67	1600 μ	68 ± 6	—	Proton
6	37 ± 3	0·480	4000	35 – 44	35–68 range only	40 ± 4	>3000 m_e	Proton or deuteron
7	68 ± 5	0·309	900	66 – 81	800 μ	68 ± 5	—	Proton
8	46 ± 3	0·416	1200	44 – 51	47–60	45 ± 3	1400 m_e	Proton
9	33 ± 2	0·544	1500	31½–35½	32½–36½	34 ± 3	>1600 m_e	Proton
10	62 ± 3	0·277	900	61 – 68	~200	63 ± 4	—	Proton
11	34 ± 2	0·523	6400	33 – 38½	38–59 range only	35 ± 2	>1280 m_e	Proton
12	66 ± 3	0·263	1200	67 – 78	~870 μ	69 ± 4	—	Proton
13	35 ± 2	0·507	2100	33 – 37½	35–39 range only	41 ± 3	1100 m_e	Probable proton
14	54 ± 3	0·327	2400	55 – 60	2100 μ	58 ± 3	1800 m_e	Proton
15	62 ± 3	0·283	950	62 – 69	200	70 ± 5	—	Proton

measurements were made at 60-μ intervals along tracks of length exceeding 1,000 μ. It should be noted that if the particle slows down appreciably in the range considered, the scattering measurements give a low estimate of the true mass.

The measurements on fifteen fast tracks are summarized in the accompanying table.

Because of the large spread in mass-value obtained from scattering measurements, it is thought that track number 6 is still consistent with its having been formed by a proton.

From the stars analysed we obtained 76 tracks produced by particles of $0{\cdot}25 < \beta < 0{\cdot}43$ with $\bar{\beta} \sim 0{\cdot}32$. Had these been produced by π-mesons, we should have expected about ten tracks to end in the emulsion. The fact that all these tracks passed out of the surfaces confirms the conclusion drawn from the table that at least 90 per cent (and probably nearly 100 per cent) of particles ejected from nuclei with velocities $0{\cdot}25$–$0{\cdot}43\,c$ are protons. This is in agreement with a previous letter[1], in which it was estimated that only one meson was produced per ten stars, and that with a mean velocity of $\sim 0{\cdot}9\,c$.

The mechanism of ejection of these fast protons is as yet not completely understood. It is not to be expected that such particles are evaporated from a 'heated' nucleus, as are the protons with energies less than 30 MeV. Some are undoubtedly 'knocked on' by the star-producing nucleons, some of which may lose sufficient energy, in such collision processes, so that they finally emerge with energies of only 50–100 MeV.

J. B. Harding

Department of Physics,
Imperial College of Science and Technology,
London, S.W.7.
Nov. 16.

[1] Harding, J. B., and Perkins, D. H., *Nature*, **164**, 285 (1949).

Antibiotics from *Aspergillus melleus*

The culture fluid of *Aspergillus melleus* Yukawa was reported by Gill-Carey[1] to show weak antibacterial activity against *Staph. aureus*, *Bact. coli*, *Myco. phlei* and *C. xerosis*. Three antibiotics have now been isolated from culture fluids of this *Aspergillus*. Two of them have been identified: they are penicillic acid and mellein.

The fungus was grown by Gill-Carey on 5 per cent malt extract medium and on a modified Sabouraud medium containing 1 per cent peptone, 4 per cent maltose and 2·6 per cent malt extract. The culture fluid was adjusted to *p*H 5 and the active material was extracted into chloroform. The acidic substances in the chloroform were extracted into *M*/10 phosphate at *p*H 8, and the phenols then removed with *N*/10 sodium hydroxide solution. The phosphate extract was brought to *p*H 3 and the acidic substances extracted into chloroform and chromatographed on a column of 'Florisil' (magnesium silicate). Evaporation of the main active fraction of the percolate left a crystalline residue which was recrystallized from aqueous alcohol. Its melting point, colour reactions and antibacterial properties were identical with those of penicillic acid[2,3]. When mixed with an authentic sample of penicillic acid there was no depression in melting point. It formed a hydroxylamine derivative, of melting point 212° C. [2].

Chromatography of material from one batch of culture fluid (modified Sabouraud medium) yielded a small amount of a second acid which was eluted from the column with an alcohol–chloroform mixture. This crystallized from carbon tetrachloride in long colourless needles of melting point 109° C. (found (Weiler and Strauss): C, 57·0; H, 6·6; $C_{17}H_{32}O_3$ requires: C, 57·3; H, 6·2 per cent). This acid gave a zone of inhibition 20 mm. in diameter when tested at 1 in 2,000 by the cylinder-plate method against *Staph. aureus*.

The sodium hydroxide solution containing the phenols was acidified and extracted with chloroform. The extract was chromatographed on 'Florisil', when a highly fluorescent substance, with weak antibacterial activity, passed through the column and crystallized from the percolate on evaporation of the solvent. It was recrystallized from aqueous alcohol, forming colourless needles of melting point 58° C. It was almost insoluble in water and in petroleum ether, moderately soluble in chloroform and ether, and soluble in acetone and alcohol (found (Weiler and Strauss): C, 67·3; H, 5·8 per cent). It formed an acetyl derivative of melting point 127° C. and a nitro derivative of melting point 160° C. Mellein, $C_{10}H_{10}O_3$, which melts at 58° C., requires C, 67; H, 5·6 per cent. It yields an acetyl derivative of melting point 126° C. and a nitro derivative of melting point 160° C. [4]; yield, 1 gm. per 5 litres culture fluid.

A second active phenol was eluted from the column with 50 per cent aqueous alcohol; but the quantity was too small for detailed investigation.

H. S. Burton

Sir William Dunn School of Pathology,
University of Oxford.
Oct. 6.

[1] Gill-Carey, D., *Brit. J. Exp. Path.*, **30**, No. 2, 117, 122 (1949).
[2] Birkinshaw, J. H., Oxford, A. E., and Raistrick, H., *Biochem. J.*, **30**, 394 (1936).
[3] Heatley, N. G., and Philpot, F. J., *J. Gen. Microbiol.*, **1**, 232 (1947).
[4] Nishikawa, E., *J. Agric. Chem. Soc., Japan*, **9**, 772 and 1059 (1933).

Epicuticle of Blow-fly Larvæ

It is now clear that in many insects the epicuticle is the waterproofing layer of the cuticle. Although difficult to define morphologically[1], it often carries a wax layer, removable by abrasion or adsorption. *Rhodnius*[2] and *Tenebrio*[3] undergo desiccation after removal of the wax layer by inert inorganic dusts; but blow-fly larvæ are unaffected[4], suggesting a different constitution of the epicuticle. Indeed, the habits of blow-fly larvæ in liquefying the food in which they burrow suggests that the prime function of the epicuticle is other than the prevention of evaporation from the surface of the cuticle. Since the food is liquefied by the secretion on it of the digestive enzymes, it is desirable to discover whether or not a function of the epicuticle is to protect the underlying protein-containing endocuticle against digestion. The great chemical stability of the outer layer of the epicuticle is in agreement with such a view, for it is not dissolved by saturated potassium hydroxide solution heated to 160° C., or by cold concentrated hydrochloric or nitric acids. On boiling with concentrated nitric acid to which potassium chlorate has been added, however, it disrupts into oily droplets which stain with Sudan Black *B*. It therefore appears to be composed of the material termed cuticulin by Wigglesworth[1,5].

Portions of the cuticle removed from larvæ of *Calliphora erythrocephala* have been treated with the fluid obtained from the semi-liquid food by diluting and filtering. After 24 hr. at 25° C., the cuticle became obviously more delicate and transparent, and failed to give readily the ninhydrin reaction shown by the fresh cuticle. After 48 hr. only a delicate membrane, similar to that remaining after treatment with acid, was left. This membrane is the outer epicuticle. No changes occur if the food extract is previously boiled, and it is clear that all the cuticle except the outer epicuticle is susceptible to digestion.

A further experiment consisted of cutting off the anterior and posterior ends of larvæ and removing the body contents from the tubes of cuticle so left. These tubular cuticles were then slipped over glass rods of suitable diameter, some with the epicuticle outwards and some turned inside out to expose the endocuticle. The ends of the cuticle were bound tightly with thread to prevent ingress of fluid between the rod and cuticle, and cuticles arranged in these ways were exposed as before for 48 hr. to the liquid food extract. The result was unequivocal. In those preparations in which the endocuticle had been protected by the overlying epicuticle, histological examination showed the cuticle to be intact, whereas when the endocuticle had been exposed nothing remained but the outer epicuticle.

This protective function of the epicuticle in blow-fly larvæ is to be regarded as an extension into the post-ecdysial period of the part played at every moult in insects generally, when the epicuticle protects the new integument against dissolution by the moulting fluid.

R. Dennell

Department of Zoology,
University, Manchester 13.
Oct. 7.

[1] Wigglesworth, V. B., *Proc. Roy. Soc.*, B, **134**, 163 (1947).
[2] Wigglesworth, V. B., *J. Exp. Biol.*, **21**, (3 and 4), 97 (1945)
[3] Alexander, P., Kitchener, J. A., and Briscoe, H. V. A., *Ann. App. Biol.*, **31**, (2), 156 (1944).
[4] Dennell, R., *Nature*, **155**, 545 (1945).
[5] Wigglesworth, V. B., *Quart. J. Micr. Sci.*, **76**, 269 (1933).

Quinone Tanning in the Animal Kingdom

Prof. R. Dennell suggests in his letter in *Nature* of August 27 that quinone tanning of protein structures may be of wide occurrence in the invertebrates. During investigations of structural proteins in the vertebrates and invertebrates, I have found evidence of quinone-tanned proteins in the central capsule membrane of *Thalassicola*, the external cortical layer of the cuticle in *Ascaris lumbricoides*, the chætæ of *Aphrodite*, the byssus[1] and periostracum of *Mytilus edule*, the byssus of *Dreissensia polymorpha* and in the egg cases of various selachian fishes. There are numerous other structures, such as the winter egg cases of planarians and the egg cases of various molluscs and earthworms which suggest, by their colour, the presence of aromatic-tanned protein. Ellerby[2] has evidence for quinone tanning in the cyst wall of eelworms.

Undoubtedly, therefore, quinone-tanned proteins are of widespread occurrence. While these various structures agree in showing very great chemical stability, there is evidence that the sequence of events leading to the tanning differs in different cases. In the tanning of the cockroach oothecæ, the precursor of the quinone is an alcohol-soluble phenol, protocatechnic acid[3,4]. In *Mytilus*, the precursor is not alcohol-soluble, and its properties suggest that it may be an aromatic amino-acid or protein, and there is evidence of a similar precursor in the hardening of the egg cases in *Fasciola hepatica*. If, in these cases, the side-chain is split off before oxidation to a quinone occurs, then the final method of tanning is not significantly different from that in insects. But if oxidation occurs without the removal of the side-chain, then it suggests a way in which quinone tanning may have evolved. Tyrosine is present in nearly all proteins and probably forms salt links through its phenolic hydroxyl group; and it is a comparatively small step to improve on this mechanism by oxidizing the hydroxyl to a quinone, which can form covalent bonds.

It is hoped to publish elsewhere a full report of this work, which was carried out at the Zoological Laboratory, Cambridge, the Marine Biological Station, Plymouth, and Stazione Zoologica, Naples.

C. H. Brown

Cancer Research Department,
London Hospital, E.1.
Oct. 5.

[1] Brown, *Exp. Cell Res.*, Supp., **1**, 351 (1949).
[2] Ellerby, *Nature*, **151**, 302 (1946).
[3] Pryor, *Proc. Roy. Soc.*, B, **128**, 378 (1940).
[4] Pryor, Russell and Todd, *Biochem. J.*, **40**, 627 (1946).

Inhibition of Human Serum Cholinesterase by some 4-Hydroxy-coumarin Derivatives

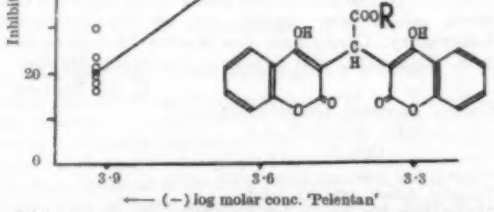
Of the esters of di(4-hydroxycoumarinyl-3)-acetic acid ('pelentanic acid' according to Fučík, Procházka and Čechová[1]), one, the ethyl ester ('Pelentan'), has been widely used as an anticoagulant. It has been reported[2] that 'Pelentan' is less toxic than dicoumarol, acts with less delay and is more quickly eliminated. During a pharmacological study of 'Pelentan', it was found that its solutions inhibit human serum cholinesterase. In continuation of these observations, a comparison has been made of the inhibition of serum cholinesterase by some esters of pelentanic acid and by dicoumarol.

As all these compounds are poorly soluble in water, they were first dissolved with three times their equivalent of sodium hydroxide, and the solutions were then adjusted to *p*H 7·4 with hydrochloric acid. Cholinesterase activity was estimated by Ammon's[3] manometric method. Each determination was made with 0·05 ml. of serum, which had been kept in the ice-box not longer than three days. Serum and inhibitor were placed in the side-bulb and the volume made up to 0·5 ml. with Ringer 30[4]. Acetylcholine hydrochloride was dissolved in Ringer 30 (1·5 ml.) and placed in the main compartment. The results did not differ when, alternatively, inhibitor was placed in the main compartment.

Cholinesterase activity was expressed in terms of Augustinsson's[4] b_{30}, which represents the volume of carbon dioxide in μl. evolved by the enzyme in 0·05 ml. of serum during the 10th to 40th minute after tipping. Eight to ten tests were made with each compound and with each concentration of 'Pelentan'. Mean values are given in the accompanying table. The variations of the results were small.

The graph shows that the relationship between the negative logarithm of concentration of 'Pelentan' and the per cent inhibition of cholinesterase is linear.

As may be seen from the table, dicoumarol has about half the inhibitory effect of 'Pelentan'. Pelentanic acid, which is derived from dicoumarol by the replacement of one hydrogen of the methylene bridge by carboxyl and has no anticoagulant properties[5], does not inhibit appreciably. Esters of the acid had inhibitory activity increasing with the length of the esterifying radical over the range C_1 to C



Inhibition of serum cholinesterase by 'Pelentan' ($R = C_2H_5$) of various concentrations; acetylcholine hydrochloride as substrate in molar concentration of $2·064 \times 10^{-4}$

INHIBITION OF SERUM CHOLINESTERASE BY DERIVATIVES OF DICOUMAROL
Final inhibitor concentration $2·24 \times 10^{-4}$ *M*; acetylcholine hydrochloride $2·064 \times 10^{-4}$ *M*

Compound	Mol. weight	% Inhibition
Dicoumarol	338	27·4
R = — H, pelentanic acid (cf. formula)	380	1·9
R = —CH_3	394	7·8
R = —$CH_2.CH_3$, 'Pelentan'	408	42·7
R = —$CH_2.CH_2.CH_3$	422	54·7
R = —$CH.(CH_3)_2$ (not completely dissolved)	422	(53·7)
R = —$CH_2.CH_2.CH_2.CH_3$	436	54·4
R = —$CH_2.CH.(CH_3)_2$	436	58·7
R = —$CH_2.CH_2.OH$	424	12·2

Straight- and branched-chain compounds of the same molecular weight were about equally effective. The glycol ester, which differs from 'Pelentan' by one —OH group in the esterifying radical, has a much lower anti-cholinesterase activity; it is also a weaker anticoagulant[6]. 'Pelentan' also inhibits the cholinesterase of rat serum.

Until *in vivo* experiments have been evaluated, no claim can be made of the physiological significance of the inhibition of serum cholinesterase by these anticoagulant drugs.

We are indebted to Dr. K. Fučík and Mr. Z. Procházka of the United Pharmaceutical Works, Prague, for the supply of all the inhibitors tested.

V. GROSSMANN
I. M. HAIS
B. KASALICKÝ

Department of Pharmacology,
Charles University,
Albertov 4, Prague.
Aug. 15.

[1] Fučík, K., Procházka, Z., and Čechová, V., *Chem. listy*, **43**, 49 (1949).
[2] Petráček, E., *Cas. lék. ces.*, **83**, 1204 (1944). Reinli, Z., and Kubík, M., *Schweiz. med. Wchschr.*, **78**, 785 (1948). v. Kaulla, K. N., and Pulver, R., *Schweiz. med. Wchschr.*, **78**, 806 (1948). Pulver, R., and v. Kaulla, K. N., *Schweiz. med. Wchschr.*, **78**, 956 (1948). Gianella, C. V., and v. Kaulla, K. N., *Experientia*, **5**, 125 (1949).
[3] Ammon, R., *Pflügers Arch. ges. Physiol.*, **233**, 486 (1933).
[4] Augustinsson, K.-B., *Acta Physiol. Scand.*, **15**, Supp. 52, 38, 24 (1948).
[5] Lehmann, J., *Lancet*, I, 458 (1943).
[6] Francová, V. (personal communication).

Demonstration of Incomplete *Rh*-Antibodies by Alpha-Globulin

A METHOD of demonstrating incomplete *Rh*-antibodies by suspending the reacting cells in a concentrated albumin solution has been described by Diamond[1]. The mechanism of the reaction is not clearly understood, and variations in the efficiency of different preparations of albumin suggest that the activating protein is not albumin, but some contaminating protein associated with it.

The fractionation of plasma by ether described by Kekwick, Mackay and Record[2], and afterwards developed for the preparation of gamma-globulin by Kekwick and Mackay[3], made available a protein solution consisting of 87 per cent albumin and 13 per cent globulins which, when concentrated to 10 per cent protein, was found to demonstrate incomplete antibodies. The globulins from a 5 per cent solution of this protein were precipitated with sodium sulphate (18 gm./100 ml. [4]). The precipitate was dissolved in 0·9 per cent sodium chloride solution to one-tenth of the original volume, and the sodium sulphate was removed by dialysis. The supernatant was concentrated and found to be inactive; but the precipitate was active at a third of the protein concentration of the original solution.

Solutions of beta- and gamma-globulin prepared by the ether fractionation of human plasma[2] were found to be inactive; but from the supernatant left after their precipitation an active fraction could be prepared by the addition of 18·5 vol. of ether per cent at − 4° C., *p*H 5·0, and ionic strength 0·035. The active fraction was soluble in 0·9 per cent saline at *p*H 5·0. Electrophoretic analysis of the soluble fraction showed that it consisted of albumin, 38; alpha-globulin, 33·4; beta-globulin, 19·7; gamma-globulin, 8·9 per cent. Albumin, separated electrophoretically from this preparation and concentrated by freeze-drying, showed no activity, but at a comparable protein concentration the globulins were highly active.

Taking all the experiments into consideration, the albumin was consistently negative, and no activity could be found in beta- and gamma-globulin. The activity appears to be associated with alpha-globulin, but no correlation with its concentration could be obtained. It is suggested that this globulin is responsible for the demonstration of incomplete *Rh*-antibody in the Diamond test.

E. A. McCulloch
(Ellen Mickle Fellow,
University of Toronto)
Blood Products Research Unit,
Lister Institute,
Chelsea Bridge Road,
London, S.W.1.
Oct. 10.

[1] Cameron, J. W., and Diamond, L. K., *J. Clin. Invest.*, **24**, 793 (1945).
[2] Kekwick, R. A., Mackay, M. E., and Record, B. R., *Nature*, **157**, 629 (1946).
[3] Kekwick, R. A., and Mackay, M. E., Proc. First International Congress of Biochemistry, 1949.
[4] Kekwick, R. A., *Biochem. J.*, **34**, 1248 (1940).

Glycogen Production from Glucose with Desoxycorticosterone and 11-Dehydro-17-hydroxycorticosterone

It is often said that the different corticosteroids have qualitatively different activities. Desoxycorticosterone is believed to act only on electrolyte metabolism, while 11-dehydro-17-hydroxycorticosterone (compound *E*) acts on glycogen production. This view is based mainly on results with methods of bio-assay in which adrenalectomized rats on a high-protein diet are given divided doses of these corticosteroids over a period of six hours; two hours after the last injection, liver glycogen is estimated[1–3].

Recently a comparison was made between the glycogenetic property of these two corticosteroids on adrenalectomized rats, which were kept on a pure protein diet[4]. It was confirmed that compound *E* has a distinctly stronger glycogenetic activity, especially after a single injection. In long-term experiments the difference was less obvious.

It was known, however, that desoxycorticosterone restores glycogen production from carbohydrate very well[5]. We have therefore compared desoxycorticosterone in the following experiments with compound *E* on adrenalectomized rats on a carbohydrate-rich diet with continuous treatment. Male rats, 140–180 gm. body-weight, kept on the stock diet, which is rich in carbohydrates, were used. Adrenalectomy was performed from the lumbar side under ether narcosis. Glycogen production was tested in the following way. The animals were fasted for twenty-four hours. Then 2 c.c. of 50 per cent glucose was given by stomach tube; three hours later they were killed, and liver and muscle glycogen estimated[4].

The course of these experiments on normal animals is shown in series 1 and 2 of the accompanying table. After twenty-four hours starvation, the glycogen values are very low; three hours after administration of 1 gm. glucose, they are raised to 3·7–5·7 gm. per cent in the liver and to 0·45–0·55 gm. per cent in muscle.

Untreated adrenalectomized animals, on the tenth to twelfth day, with the first signs of adynamia, showed after glucose feeding a much decreased glycogen production (series 3).

We then treated six adrenalectomized animals for eight days with 1 mgm. desoxycorticosterone daily. Then three animals had for three days 0·5, 1·0 or 2·0 mgm. desoxycorticosterone daily (series 4) and the three other adrenalectomized animals 0·5, 1·0 or 2·0 mgm. compound *E* daily (series 5). On the twelfth day, after twenty-four hours starvation, they were fed with 1 gm. glucose, and after three hours glycogen was estimated. In both groups this was as high as in the normal animals. No difference was found between the action of the two corticosteroids.

In series 6, two animals were treated after the adrenalectomy with 1 mgm. desoxycorticosterone daily, and in series 7 three animals with 1 mgm. compound *E* daily for 15 days. Then, after twenty-four hours starvation, 1 gm. glucose was fed and glycogen estimated after three hours. Normal glycogen values were found in all these animals, as the table shows. For desoxycorticosterone this is only a confirmation of many former experiments[5].

Thus treatment for several days with 1 mgm. desoxycorticosterone or 1 mgm. compound *E* daily shows equal restoration of the capacity to produce glycogen from carbohydrate sources. While it may be that a larger number of experiments (if more material were available of the latter substance) might show a difference between the activity of these two corticosteroids, these experiments certainly demonstrate that their activity on glycogenesis from carbohydrates is very similar.

Series	Experiment	No. of animals	Glycogen content (gm. per cent) in liver					in muscle				
1	Normal animals—24 hr., starvation	5	0·10	0·10	0·10	0·12	0·10	0·25	0·22	0·34	0·19	0·25
2	Same, but 3 hr. after 1 gm. glucose	5	3·70	3·70	3·75	3·75	5·70	0·45	0·54	0·55	0·45	0·42
3	Adrenalectomized after 10–12 days untreated*	3	1·35	1·43	0·92	—	—	0·37	0·45	0·40	—	—
4	Same, 8 days treated with 1 mgm. desoxycorticosterone, then 3 days with 0·5, 1·0, 2·0 mgm. of it*	3	5·50	4·00	3·80	—	—	0·46	0·45	0·73	—	—
5	Same, 8 days treated with 1 mgm., then 3 days with 0·5, 1·0, 2·0 mgm. *E**	3	5·15	4·75	7·00	—	—	0·59	0·58	0·56	—	—
6	Same, treated 15 days with 1 mgm. desoxycorticosterone	2	3·30	4·70	—	—	—	0·47	0·55	—	—	—
7	Same, treated 15 days with 1 mgm. *E**	3	5·00	2·80	4·80	—	—	0·53	0·44	0·69	—	—

* After twenty-four hours starvation and three hours after 1 gm. glucose *per os*.

We thank Ciba A.G., Basle, for desoxycorticosterone acetate (Percorten) and Merck, Ltd., Rahway, for compound *E*-acetate which was kindly given for these experiments.

F. C. WANG
(Chinese Government Scholar)

Physiological Laboratory,
University of Basle.
Aug. 26.

[1] Olson, R. E., Thayer, S. A., and Kopp, L. J., *Endocrin.*, **35**, 464 (1944).
[2] Pabst, M. L., Sherppard, R., and Kuizenga, M. H., *Endocrin.*, **41**, 55 (1947).
[3] Venning, E. H., Kazmin, V. E., and Bell, J. C., *Endocrin.*, **38**, 79 (1946).
[4] Wang, F. C., and Verzár, F., *Amer. J. Physiol.*, **159**, 263 (1949).
[5] Saas-Kortsák, A., Wang, F. C., and Verzár, F., *Amer. J. Physiol.*, **159**, 256 (1949).

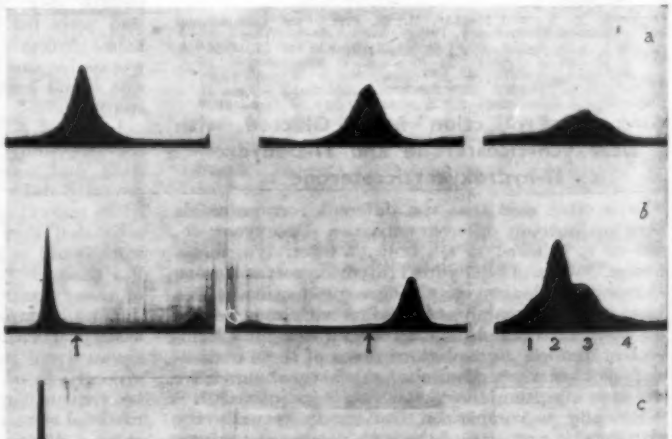
Electrophoretic Heterogeneity of Crystallized Pepsin

CRYSTALLIZED pepsin has been shown by Tiselius *et al.*[1] to give one sharp and a second, diffuse, boundary, visible at higher concentrations only. During electrophoresis, inactive material was removed and the specific activity of the pepsin was raised by 31–69 per cent. These authors concluded that the homogeneity of the migration of the active component is not sufficient evidence *per se* for the chemical individuality of the enzyme. Solubility studies revealed several components possessing different activities (refs. in Sumner and Somers[2]).

With the object of resolving the pepsin into components by electrophoresis, a sample of crystallized pig pepsin (made by Armour Laboratories) was studied in the Tiselius apparatus. By the standard technique 96 per cent of this material appeared to be homogeneous at *p*H 3·9 and 5·9, as well as at *p*H 8, at which *p*H pepsin is inactivated (see illustration, left and centre). The slower component (4 per cent of the total, Fig. *b*) was possibly the same as that observed by Tiselius *et al.*[1] as the diffuse boundary. Prolonged electrophoresis, however, disclosed the heterogeneity of the preparation at all three *p*H's (see illustration, right). The pattern at *p*H 5·9 showed the components most clearly. The percentages of the areas under the peaks were, counting from the fastest component, 1 = 11; 2 = 55; 3 = 24; 4 = 10. On account of the similarity of the mobilities of the components, these values should not be taken to represent the relative proportions of the components in the mixture. The true proportions can be calculated for the case of two components by an equation derived for the limiting conditions of low protein concentrations[3].

Since the peaks of components 1 and 4 were small, their areas were combined with those of 2 and 3 respectively in order that this equation might be applied. In the derivation of the equation, two assumptions were made[3]: (*a*) that the relative rate of change in migration velocity with protein concentration (expressed in gm./100 ml.) is the same for both components; (*b*) that the relative rate of change of the migration velocity of one component, when at infinitely low concentration, with increasing concentration of the second component, is equal to the relative rate of change of the migration velocity of the second component with increasing concentration of this component. These two assumptions impose fewer restrictions on the choice of the system to be studied than the assumption of constant mobility ratios[4] or constant relative mobilities[5] of all ions. They imply, however, that there is no specific interaction or formation of dissociable complexes of the two colloid components.

The absence of interaction or complex formation can be ascertained when both the ascending and the descending patterns give, at low colloid concentration, the same relative proportions of the areas under the peaks. But if the components differ little in mobility, only the ascending pattern may be available for analysis, and in consequence complex formation cannot be excluded by this means. The reason for the increase in concentration of the faster component ahead of the boundary of the slower component is the decrease in the migration-velocity of the faster



Electrophoretic patterns of crystallized pepsin.

	Buffer	*p*H	Ionic strength	Pepsin conc. (gm./100 ml.)		Distance migrated (cm.)
(*a*)	Acetate	3·9	0·02	0·6	left	3·1
					centre	3·2
					right	10·5
(*b*)	Phosphate	5·9	0·025	0·9	left	2·2
					centre	2·4
					right	29·4
(*c*)	Phosphate	8·0	0·10	1·2	left	2·3
					centre	1·9
					right	20·0

component as it leaves the region of the mixture. If a complex is formed between the two components, the average migration-velocity of the faster component in the mixture is decreased; consequently the difference in the migration-velocity of this component below and above the boundary of the slower component is also decreased and the increase in concentration diminished. Minimum values only are therefore given for the concentration of the faster component in the mixture by the equation:

$$C_f' = \frac{C_f'}{1 + \frac{V_1}{S} K(C_f' - C_f')} \quad (1)$$

In the experiment recorded in Fig. *b*, the following experimental values were found: distance migrated at infinitely low protein concentration, $t \times V_t = (t \times V_{ai})/(1 + KC_f') = 28{\cdot}1$ cm. (t is time of migration, V_{ai} is actual migration velocity); separation of the peaks, $t \times S = 0{\cdot}43$ cm.; total concentration below the ascending boundary, $C_f' = 0{\cdot}70$ gm./100 ml.; apparent concentration of faster component, from area measurements, $C_f' = 0{\cdot}46$ gm./100 ml.; K, defined as $(1/C_f)\ (V_{ai} - V_f)/V_f$, was determined by a differential method[6] in which the concentrations of the dilute upper and the concentrated lower, adjusted solutions were 0·084 and 0·70 gm./100 ml. respectively, $(1/C_f' - C_f')\ (V_{conc.} - V_{dil.})/V_{dil.}$ being used for the calculation as a near approximation. K was found to be 0·035, signifying an increase of 3·5 per cent in the migration velocity of the ascending boundary per unit concentration of pepsin. Inserting the experimental values in equation (1), the true concentration of the faster components (1 and 2) in the mixture, C_f', is 0·3 gm./100 ml. or 43 per cent of the total; apparent proportion is 66 per cent. The relative difference between the migration velocities of the two main boundaries was 1·5 per cent; the calculated relative difference between the mobilities was 2·3 per cent.

The activity of the enzyme was determined by the method of Anson[7]; the nitrogen concentrations of the protein filtrates and of the pepsin solutions were determined by the micro-Kjeldahl method. Human haemoglobin was used as substrate. The following specific activities were found, the activity of the freshly made solution being taken as 100: (1) solution of 0·9 gm./100 ml., kept 48 hr. at 0–4° in phosphate at pH 5·9 = 112; (2) solution of 0·9 gm./100 ml. dialysed 48 hr. at 0–4° against phosphate at pH 5·9 = 122; (3) solution of 0·7 gm./100 ml. taken from the ascending side after prolonged electrophoresis at pH 5·9 = 115. The increase in the specific activity after dialysis may be due to removal of inactive material or an inhibitor by dialysis or preferential adsorption on the dialysing membrane.

The patterns of Fig. *b* were obtained after the pepsin had been in solution for not more than 28 hr. The two peaks may represent two different enzymes.

H. Hoch

Department of Chemical Pathology,
London Hospital Medical College,
London, E.1. Sept. 21.

[1] Tiselius, A., Henschen, G. E., and Svensson, H., *Biochem. J.*, **32**, 1814 (1938).
[2] Sumner, J. B., and Somers, G. F., "Chemistry and Methods of Enzymes" (Academic Press, Inc., New York, 1947).
[3] Hoch-Ligeti, C., and Hoch, H., *Biochem. J.*, **43**, 556 (1948).
[4] Svensson, H., *Ark. Kem. Min. Geol.*, **22**, No. 10 (1946).
[5] Dole, V. P., *J. Amer. Chem. Soc.*, **67**, 1119 (1945).
[6] Hoch, H., *Biochem. J.*, **42**, 181 (1948).
[7] Anson, M. L., *J. Gen. Physiol.*, **22**, 79 (1938).

Hepatic and Splenic Sympathin

Because of the desire to identify the substances liberated by adrenergic nerves, much work has been devoted to the search for really sensitive and specific methods for detecting and estimating adrenaline and allied substances in blood. Some of the difficulties of these estimations in heparinized blood from cats and man have been discussed by Gaddum, Peart and Vogt[1], who selected five sensitive tests for detailed study. By making parallel quantitative assays, closely allied sympathomimetic amines can be distinguished from one another. Using these criteria, Peart[2] found that all the evidence supported the view that the active material released by the adrenergic nerves in the cat's spleen was *nor*adrenaline, although smaller amounts of adrenaline were sometimes also liberated. In a similar series of cats, we now record the proof that the active material is *nor*adrenaline, which may be found in the blood of the splenic vein in concentrations up to 0·3 μgm./ml. plasma. In addition, in six out of fifteen experiments, adrenaline in quantities less than 0·01 μgm./ml. plasma has been detected and estimated, and these amounts were usually found in samples obtained during the first stimulations only[3].

All the work has been completed on cats under chloralose, heparin being used as the anticoagulant. Blood samples were collected from the splenic vein into graduated centrifuge tubes standing in ice, and then centrifuged. The pharmacological tests used for the assays were: (1) inhibition of the rat's non-pregnant uterus in dioestrus, (2) inhibition of the week-old chick's rectum at 37° C., and (3) contraction of the chronically denervated nictitating membrane of a cat under chloralose, injections of the drugs or samples being made into the side arm of a special cannula in the carotid artery[1]. When mixtures of adrenaline and *nor*adrenaline were added to control samples of plasma, accurate estimates were obtained by these tests when the activities were calculated by the formula employed by Bülbring[4]. As little as 4 per cent of one of the amines could be accurately measured in a mixture of the two.

In other experiments, stimulation of the rat's non-pregnant uterus in full œstrus (when cornified cells are in the vaginal smear) was also used as confirmatory evidence, this being abolished by dibenamine. In addition, the samples caused contraction of the cat's spleen and increased the force and rate of the frog heart-beat.

In most cases, stimulation of the nerves was completed in one minute, although the 'post-stimulus' sample of plasma was collected over three minutes (during and following the stimulation period). A typical series of results for the sympathin concentration in the post-stimulus samples of plasma in terms of the two amines is shown in the accompanying table. The pre-stimulation samples had no action when tested in a similar manner, and ligation of the adrenal vessels did not affect the result.

Sympathin concentrations (μgm./ml.) in the post-stimulus samples of plasma in terms of adrenaline or *nor*adrenaline

Sympathin estimated as	Rat non-pregnant uterus in dioestrus	Chick rectum	Cat's nictitating membrane
L-Adrenaline (*A*)	0·0025	0·01	0·25
L-*nor*Adrenaline (*N*)	0·125	0·20	0·25
Ratio *A*/*N*	0·02	0·05	1·0

By formula, the mean value for *nor*adrenaline is 0·25 μgm./ml., while the adrenaline value is zero.

Further evidence that the main active material is *nor*adrenaline is provided by the fact that the post-stimulus samples stimulated the rat's non-pregnant uterus in early œstrus (when nucleated epithelial and cornified cells are in the vaginal smear), whereas adrenaline relaxed this tissue at this stage of the œstrus cycle[5].

Using these methods of estimating the sympathin, we have now stimulated the hepatic nerve in cats after attaching two threads around the inferior vena cava, one above the diaphragm and the other between the liver and the adrenal glands. Blood samples, taken from the hepatic vein via a syringe and a No. 13 needle[6], were centrifuged and tested on the preparations described above. The active adrenergic material was *nor*adrenaline, which may be found in the blood of the hepatic vein in concentrations up to 1·05 μgm./ml. plasma. In addition, in two out of twelve experiments, adrenaline in quantities less than 0·003 μgm./ml. plasma has been detected and estimated.

We are proceeding with the investigation in an attempt to identify the sympathin liberated by other adrenergic nerves. The work would not have been possible without the technical assistance of Mr. G. Ayerst, to whom our thanks are due.

Monica Mann
G. B. West

Pharmacology Department,
School of Pharmacy,
University of London,
17 Bloomsbury Square,
London, W.C.1.

[1] Gaddum, J. H., Peart, W. S., and Vogt, M., *J. Physiol.*, **108**, 467 (1949).
[2] Peart, W. S., *J. Physiol.*, **108**, 491 (1949).
[3] West, G. B., *Nature*, **163**, 721 (1949).
[4] Bülbring, E., *Brit. J. Pharmacol.*, **4**, 234 (1949).
[5] Mann, M., *J. Physiol.*, **110**, 11*P* (1949).
[6] D'Silva, J. L., *J. Physiol.*, **85**, 219 (1936).

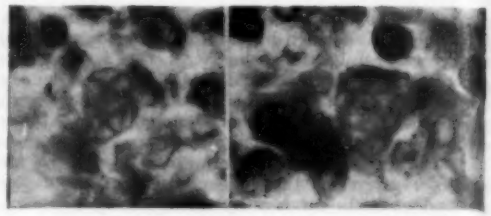
Secretion of Red Blood Corpuscles as Seen in the Camel

We have been fortunate enough to receive some camel organs which enabled us to proceed with the research on red blood corpuscle secretion in this animal and to complete our previous studies on its eosinophil cells[1]. Some interesting observations were made in the liver, spleen and gastric and intestinal mucosæ.

In the spleen, the development of the eosinophil can be studied at its best, and cells of different sizes can be found containing granules in various stages of evolution, some being fully matured red blood corpuscles. The diameter of some of the cells has been calculated to contain more than twenty of these mature red-blood corpuscles, and it is a remarkable fact that, in spite of their size, some of the granules always retain their oval shape (see photomicrographs). A large number of mononuclears have been found, some of them having a lymphocytic nucleus and containing one or two fully developed red blood corpuscles.

In the liver, occasional eosinophil cells can be seen; but in this organ it is not possible to demonstrate the presence of very large cells in the process of secretion.

The gastric mucosa of the camel enabled us to show that the eosinophil can be linked with the



Camel spleen. Blood-secreting cells in different phases of secretion. Notice the oval shape of the granules

oxyntic cells, as we have established in other animals, especially the Herbivora (cow, sheep and horse). In the camel, however, the oxyntic granules are not so large as they are in the latter animals, and it is more difficult to see them developing *in situ*. If the granules are studied carefully and individually, it soon becomes apparent that they are not round in shape; but some have a definite oval appearance. Similar observations apply to the Paneth cells in the small intestine, and in this organ the eosinophils can be found in large numbers at the top of the villi.

This evolution of the eosinophil upholds the secretion of the red blood corpuscles as against the accepted theory of phagocytosis; for if this latter theory were correct, the red blood corpuscles would not require to keep their oval shape or to shrink in size before destruction. Hence the view that fully matured red-blood corpuscles are evolved from the eosinophil is easier to understand than the phagocytosis of the red blood corpuscles which causes the cell to shrink and become an eosinophil.

This work has been made possible by the collaboration of Mr. J. R. Evans, of the Sudan Veterinary Service, and the kindness of Dr. D. O'Brien, who sent me some camel organs spontaneously from Somalia.

Frederic Duran-Jorda

Pathology Department,
Ancoats Hospital,
Manchester 4.
Sept. 21.

[1] Duran Jorda, F., *Lancet*, ii, 451 (Sept. 18 1948).

Relation between Vitamin B_{12} and the Red Blood Cells

The chemistry and biochemical function of vitamin B_{12} are at present the subject of intensive study. A feature which distinguishes this substance from other therapeutic agents is its effectiveness in very small amounts. While the amount which is adequate for the treatment of pernicious anæmia in relapse varies in individual cases, an initial dose of about 10 gamma (that is, 10^{-2} mgm.) is generally effective. The smallness of these effective amounts has aroused comment; but a simple calculation (as follows) shows that the quantities of B_{12} required appear to throw some light on its significance in the blood picture.

The number of B_{12} molecules in 10 gamma can be calculated from the following equation:

$$\text{No. of molecules} = \frac{\text{Wt. of 10 gamma in gm. (gm. mol. No.)}}{\text{Mol. weight } B_{12}} = \frac{10 \times 10^{-3} \times 10^{-3} \times 6 \times 10^{23}}{1{,}300} = 5 \times 10^{15}.$$

The average number of red blood cells in the blood fluid of an adult human in good health is about 5 million per c.mm. [1]; thus the total number of red blood cells is obtained from this number and the total volume of blood fluid, which is about 6 litres. The total number of red blood cells is therefore

$$5 \times 10^6 \times 10^3 \times 10^3 \times 6 = 3 \times 10^{13}.$$

In the condition of pernicious anæmia in relapse, the number of red blood cells may fall to half this number or even less.

If the number of molecules in an effective dose of vitamin B_{12} is compared with the total number of red blood cells, it is apparent that there is more than enough vitamin B_{12} for a one-to-one correspondence, and there is available an excess for a depot storage in the liver. The close accord of these numbers is very suggestive and the smallness of the therapeutic doses no longer appears surprising, nor does vitamin B_{12} appear to be behaving as a catalyst. Since the effect of injecting vitamin B_{12} is rapidly to raise the number of reticulocytes, the precursors of the erythrocytes, it appears probable that at least one vitamin B_{12} molecule interacts, at an earlier stage of the normoblast process, with one blood cell. Thus it seems likely that the vitamin B_{12} molecule provides in some manner an essential unit for each *individual* blood cell in an early stage of its development. If this hypothesis is valid, then it opens up possibilities for further investigations.

C. Ockrent

The British Drug Houses, Ltd.,
Graham Street, London, N.1.
Oct. 27.

[1] Whitby and Britton, "Disorders of the Blood" (Churchill, 1946–49).

Minimum and Maximum Limits of Photon-Energy

Milne[1] has recently suggested that Planck's 'constant' h may vary with time, the variation being significant for the interpretation of the spectra of distant galaxies. According to Milne's discussion, h varies linearly with t, the present value of the latter being of the order of 2×10^9 years. This possibility has the particular merit of reconciling the observed red-shifts with the principle of conservation of energy. It is the object of the present letter to point out some other significant consequences of Milne's law.

First, we note that this law has an important bearing on the physical dimensions of Planck's constant. For, if h varies linearly with t, then h/t must be a fundamental constant of energy which, unlike h, will be a secular invariant. Hence, the fundamental constant will now be a natural unit of energy, the value of h at any cosmic epoch being obtained by multiplying this unit by that epoch.

Secondly, we consider the possible identification of this new unit. Taking $h \sim 6 \times 10^{-27}$ erg-sec. and $t \sim 6 \times 10^{16}$ sec., we find that

$$\frac{h}{t} \sim 10^{-43} \text{ ergs.} \qquad (1)$$

This is equal to the inertial energy of a rest-mass,

$$\frac{h}{c^2 t} \sim 10^{-64} \text{ gm.} \sim \frac{m}{\sqrt{N}}, \qquad (2)$$

where m is the mass of the proton and N is Eddington's number 10^{79}. (This number indicates the order of magnitude of the equivalent number of protons in a universe of mass 10^{55} gm., a numerical value which arises in many otherwise widely different theories of world-structure[2].) Substituting $r\sqrt{N}$ for ct in equation (2), we can immediately isolate the well-known fundamental unit of length,

$$r \sim \frac{h}{mc}. \qquad (3)$$

This unit, of course, is comparable with the radius of the proton ($\sim 10^{-13}$ cm.). The length ct, on the other hand, is equivalent to the 'radius of the universe', both in Milne's theory and in Eddington's.

It is natural to ask: What are the minimum and maximum theoretical limits of photon-energy? Since, in standard notation, $E = h\nu = hc/\lambda$, it follows that the minimum E will be given by maximum λ, and it is reasonable to assume that this is comparable with ct. The corresponding $E_{\text{min.}}$ is, therefore, h/t, that is, the fundamental unit of energy already isolated. On the other hand, if we assume that minimum λ is comparable with the fundamental unit of length r, given by (3), the corresponding $E_{\text{max.}}$ is given by

$$E_{\text{max.}} \sim \frac{hc}{r} \sim mc^2, \qquad (4)$$

and so is comparable with the inertial energy of the proton.

These simple calculations suggest further questions: in particular, if m, the mass of the proton, is the largest possible rest-mass for an 'elementary particle', is $m/\sqrt{N} \sim 10^{-64}$ gm. the smallest possible rest-mass, and if so, are there material particles far less massive than any so far observed? If the rest-mass of the neutrino, for example, were of this order of magnitude, its energy and momentum could be significant experimentally provided its velocity were sufficiently close to c.

G. J. Whitrow

Department of Mathematics,
Imperial College of Science and Technology,
London, S.W.7.
Oct. 12.

[1] Milne, E. A., "Kinematic Relativity", chap. 8 (Oxford, 1948).
[2] Whitrow, G. J., *Nature*, **158**, 165 (1946).

Schumann–Runge Absorption Bands in Heated Oxygen

The development in emission of the Schumann–Runge system of O_2, throughout the greater part of the ultra-violet transmitted by quartz, was recently reported by one of us[1,2]. In the region below 2500 A. the necessity of using fast coarse-grain plates resulted in impaired definition, and accurate measurement was not possible. At the same time, well-resolved rotational structure was desirable in this region; first for the continuation of the rotational analysis which has now been performed for most of the new bands lying above 2500 A.[3]; secondly, since an accurate wave-length list of the band lines in this region seems likely to be an important requirement in the near future, consequent upon the extension of the ultra-violet solar spectrum beyond the ozone limit. The latter point is emphasized by Babcock's identification in the solar spectrum of part of the Schumann–Runge system in the 3000–4000 A. region[4].

For these reasons it appeared to us that the bands below 2500 A. might be better obtained by absorption in the heated gas. Earlier work by Füchtbauer and Holm[5], who studied the absorption spectrum of oxygen heated to about 1,000° C., led to the identification, and subsequent rotational analysis by Ossenbrüggen[6], of the following bands in the 2000–2200 A. region: $v'' = 2$, $v' = 5$; $v'' = 3$, $v' = 5$ to 8; $v'' = 4$, $v' = 5$ to 8; $v'' = 5$, $v' = 5$ to 7.

In the experiments now reported, a slow current of oxygen was maintained in an alumina tube, which was heated to near its softening point (~ 1,900° C.) by an oxy-hydrogen torch. Exposures were made on an *E*1 spectrograph, a hydrogen tube providing the background continuum.

The plates (Ilford *Q*1) show band structure well resolved and in good intensity over the region from 2500 A. to the instrumental cut-off at about 2125 A. The following bands can be picked out by inspection and comparison with the previous emission pictures[3]: (2,6), (3,5), (3,6), (3,7), (4,5), (5,4), (5,5), (6,5). The last three of these were previously measured by Ossenbrüggen; but there appears to be a development on our plates of rotational lines to considerably higher *J*-values. In addition, there remains a good deal of complex rotational structure, which cannot be assigned to particular bands without measurement; it is to be anticipated that unidentified bands such as (4,4), (4,6) are present.

The results of the measurements will be published later, including, if possible, a wave-length list of all lines observed in emission and/or absorption from 2125 A. to 3200 A. It would seem desirable for completeness that the bands obtained by Füchtbauer and Holm[5] should be re-measured, as the measurements were based on Eder's copper-spark standards, which were later shown by Shenstone to be in error by as much as 0·1 A.

W. R. S. Garton
M. W. Feast
Imperial College of Science and Technology,
London, S.W.7.
Oct. 8.

[1] Feast, M. W., *Nature*, **162**, 214 (1948).
[2] Feast, M. W., *Proc. Phys. Soc.*, **62**, 114 (1949).
[3] Feast, M. W. (in course of publication).
[4] Babcock, H. D., *Astrophys. J.*, **102**, 154 (1945).
[5] Füchtbauer, C., and Holm, E., *Phys. Z.*, **26**, 345 (1925).
[6] Ossenbrüggen, W., *Z. Phys.*, **49**, 167 (1928).

Sensitivity of Ants to Polarized Light

The work of von Frisch[1] has shown that the honey-bee is sensitive to the plane, and possibly to the degree, of polarization of light. Von Frisch himself suggests that some old observations made by Santschi[2] on the homing of ants could be interpreted as suggesting a similar sensitivity. Santschi's experiments, done during summer evenings in the Tunisian desert, showed that some individuals (notably of the genera *Cataglyphis* and *Monomorium*), when returning to their nests, were able to continue in the correct direction although surrounded by a tubular screen of black board. This screen, 50 cm. in diameter and 25 cm. high, restricted the field of view to an arc of sky subtending an angle of 90° at the ant: the sun was excluded by a further screen when necessary. When a flat, horizontal screen was substituted for the tube, the orientation of the ants was disturbed. These experiments have remained almost unnoticed and, unless one accepts Santschi's own theory of sidereal orientation, apparently uninterpreted.

During the late summer of 1949 the problem was investigated in three ways. (1) Santschi's experiments were repeated. The work was done in the flat water-meadows adjoining the River Cherwell, and all the results given below were obtained during the evening under a clear blue sky. The species used was *Myrmica lævinodis* (Nyl.). The tubular screen was 25 cm. in diameter and 30 cm. high, the corresponding arc of sky subtending an angle of 67°. Santschi's observations were largely confirmed. Of the ants studied, 22 per cent were immediately disturbed when the screen was placed in position, 58 per cent set off or continued in the correct direction toward their nest, and of the remaining 20 per cent half took the correct direction when the screen was removed. Further experiments are being undertaken to investigate the effect of other weather conditions, the position of the sun and the use of 'Polaroid' screens.

(2) A laboratory investigation of the sensitivity of *Myrmica ruginodis* (Nyl.) to plane-polarized light was made. A slightly divergent beam of light was thrown vertically downwards on to a flat, horizontal surface. The beam, which was circular in section, passed through a sheet of 'Polaroid G' mounted between two glass plates. The 'Polaroid' disk could be rotated about its vertical axis without visibly disturbing the beam. In the control experiments, the 'Polaroid' was replaced by a sheet of ordinary glass. Under these control conditions, an ant, placed on the flat surface in the beam of light, wandered about, seldom walking for more than 4 cm. in any one direction. Rotation of the glass had no apparent effect upon the movements of the ant. When the 'Polaroid' was present, however, an ant would eventually set off in a straight line, and would continue in the same direction for 10–20 cm. Hence it appears that the ants are able to orientate themselves to a dorsal beam of plane-polarized light, but not to one of ordinary light.

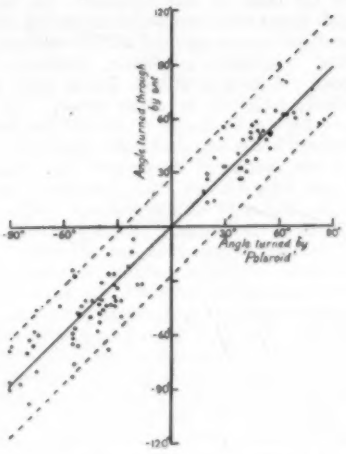
If, however, after the ant had travelled about 5 cm., the 'Polaroid' was rotated, the movement of the ant was disturbed; it either stopped temporarily and then wandered short distances at random before setting off in another, unpredictable direction, or, smoothly changing direction, set off in another straight line without other apparent disturbance. Four such changes were recorded with each ant.

Number of 'runs' made	343
Number with smooth change of direction	118

Of the second group, only thirteen readings showed an ant turning in the opposite direction (clockwise or anticlockwise) to the turning of the 'Polaroid'. The remaining 105 readings were plotted on a graph of angle ant turned/angle 'Polaroid' turned (A/P). A scatter diagram was obtained. The calculated regression of A on P (assuming uniform variance) is

$$A = 0{\cdot}1715 + 0{\cdot}9808P,$$

which is not significantly different from $A = P$. This implies that the ants maintain a constant angle of orientation relative to the plane of polarization of the light. Confidence lines were calculated, between which 95 per cent of the points fall: they are shown as broken lines on the graph. They lie 27° above and below the regression line, and this angle may be an indication of the possible accuracy of



orientation. The angle between the axes of adjacent ommatidia is about 8°.

(3) The optical system of the ant's compound eye was examined with reference to polarized light. The results are complex and merit a discussion too long to be included here.

It seems reasonable to suppose that the above results demonstrate both the sensitivity of ants to the plane of polarization of light and their ability to orientate themselves by means of this sensitivity. While neither the mechanism nor the importance of this property in the field is known, it is thought that both the methods and results of the preliminary demonstration may be of interest to workers beyond the rather limited field of ant behaviour.

D. M. Vowles

Dept. of Zoology and Comp. Anatomy,
University Museum,
Oxford.
Sept. 26.

[1] Von Frisch, K., *Experientia*, **5**, 142 (1949). See review by Thorpe, W. H., *Nature*, **164**, 11 (1949).
[2] Santschi, F., *Mem. Soc. vaud. Sci. Nat. 1923*, 137 (1923).

Ciliary Feeding Mechanisms in Anuran Larvæ

The feeding mechanism and mode of feeding of tadpoles of *Xenopus lævis* have been described, notably by Bles[1] and by Weisz[2]. These workers agree in postulating a ciliary mechanism; but their accounts of the nature and functioning of this mechanism differ widely. Bles recognized a ciliated pharyngeal groove lying along the outer margin of the branchial chamber on each side as the main food-collecting channel. Weisz, on the other hand, holds that food particles never reach the branchial chambers, and makes no mention of the ciliated paths which lie at their outer margins and converge on the œsophagus. He states that the middle region of the pharyngeal floor (called by him the "pharyngo-branchial tract" and said to be ciliated) is responsible for creating ciliary currents by which food particles pass backwards into the alimentary canal.

Recent work here has shown the earlier account of Bles to be correct. In particular, it has not been found possible to demonstrate the presence of cilia on the pharyngo-branchial tract, though rhythmical movements of this area during gulping may serve to direct incoming food particles into the branchial pouches. On the other hand, the ciliated pharyngeal grooves and their subsidiary channels in the branchial chambers can be demonstrated very convincingly by the use of finely powdered carmine, or colloidal graphite[3], especially the latter. They are easily visible through the transparent wall of the pharynx within a few minutes of adding the material to water in which the tadpoles are living.

The feeding mechanism of these tadpoles has been compared with that of *Amphioxus* and the ammocœte larva of the Cyclostomata. These organisms, however, exemplify ciliary feeding in the fullest sense illustrated by many invertebrates, that is, both the initial feeding current and the local internal collecting currents are created by ciliary action. In the larval *Xenopus*, however, the feeding stream is dependent on the activity of typical masticatory muscles, the action of which sustains the continuous gulping movements so characteristic of these tadpoles. The ciliary feeding of *Xenopus* larvæ thus combines a ciliary mechanism for food collection and subsequent transportation of a type commonly found in invertebrates or sedentary forms with a masticatory mode of ingestion characteristic of active Gnathostomata. The ciliary part of this apparatus would appear to be an adaptation for microphagy, and may be correlated with absence of peristalsis in the œsophagus. The larval stomach is modified for packing the thin mucous strings charged with food, and seems to have no obvious digestive function. No food particles are liberated in it from the mucus.

Barrington[4], after studying the development and histology of the stomach of larvæ of *Rana temporaria* and *Bufo bufo*, suggested feeding in Anuran tadpoles is fundamentally microphagous. Preliminary experiments with the tadpoles of these two forms show that their feeding mechanisms are essentially similar to that of *Xenopus*. The pharynx is, of course, relatively smaller and less specialized, and 'gulping' is much more rapid; but the particles liberated by the buccal rasp, and particles in suspension in the water, enter the mouth by the gulping activity of the masticatory muscles, and are conveyed to the œsophagus in mucus by ciliary action. As in *Xenopus* larvæ, the stomach serves to pack the mucous strings. Particles of colloidal graphite in the size-range 0·2–2·0 μ are efficiently extracted from water by both these tadpoles, and appear embedded in mucous strings in pharynx, œsophagus, and stomach within a few minutes of the tadpoles being placed in the suspension. Moreover, tadpoles of *R. temporaria* and *B. bufo* have been successfully reared through metamorphosis on a diet of particles of dried liver which would pass through a 200-mesh-per-inch sieve. It may also be noted that Kratochwill[5] has described a ciliary food-collecting mechanism in the larvæ of *Rana agilis*.

I am indebted to Messrs. Acheson Colloids, Ltd., of London, S.W.1, for a supply of 'Aquadag' colloidal graphite.

J. M. Dodd

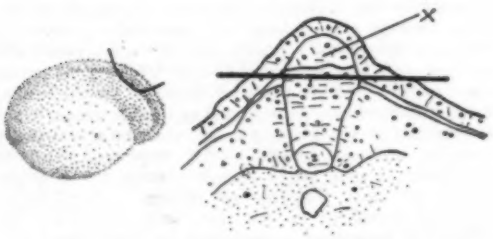
Department of Natural History,
University, St. Andrews.
Sept. 27.

[1] Bles, E. J., *Trans. Roy. Soc. Edin.*, **41**, Pt. 3 (1905).
[2] Weisz, Paul B., *J. Morph.*, **77**, No. 2 (1945).
[3] Jorgensen, C. B., *Nature*, **163**, 4154 (1949).
[4] Barrington, E. J. W., *Proc. Zool. Soc. Lond.*, **116**, Pt. 1 (1946).
[5] Kratochwill, K., *Z. f. wiss. Zool.*, **144**.

Fate of the Neural Crest in Lampreys

THE favourable nature of amphibian material has permitted the unequivocal demonstration, by both histological[1,3] and experimental[2,4] techniques, of the neural crest origin of most of the splanchnocranium and of the anterior portion of the trabeculæ cranii in these animals. In no other vertebrates is the position so clear; but in selachians[5] and birds[6] a similar origin has been claimed for the visceral bars as a result of studies of normal developmental stages. In cyclostomes the fate of the neural crest and the origin of the head skeleton is of particular interest in view of the doubt cast by Balfour on the homology of the visceral skeleton of lampreys with that of gnathostomes, and the suggestion of Sewertzoff and of de Beer[7] that the 'trabeculæ cranii' of these animals are not visceral elements but are more properly regarded as anterior parachordals.

Study of the normal development of *Lampetra* has led to conflicting opinions on the origin of its branchial skeleton and 'trabeculæ'. Koltzoff[8] and Damas[9] agree that the branchial basket is of ectomesenchymal origin, while Hatta[10] regarded it as derived from mesodermal mesenchyme. Koltzoff[8] and Johnels[11] believe the 'trabeculæ' to be derived from the sclerotome of the anterior head segments, whereas Damas[9] holds that they are of ectomesenchymal origin. These differences reflect the difficulties of the material as an object for histological study. *Intra-vitam* staining is particularly difficult on lamprey eggs, and it is doubtful if the techniques at present in common use would succeed in marking the cell groups involved over the long period necessary to obtain decisive results. There remains the possibility of extirpating the neural crest and examining the larvæ for deficiencies as a preliminary to the investigation of other possible sources of ectomesenchyme.



The extent of the tissue removed in a typical operation. Neural crest is indicated by *X*

This I have been able to do on a small series of embryos of *Lampetra planeri*. Embryos at, or a little beyond, the stage at which they possess three somites suffered the removal of portions of the head neural crest and possibly some of the dorsal part of the medullary cord as well (see figure). Different regions were extirpated in different embryos, but in all cases the removal of tissue was meant to be bilateral in the affected region. Of some sixty experimental animals, fifteen survived long enough (24–26 days, 6·8–7·2 mm. in length) to provide clear evidence of any deficiency in the primary visceral skeleton or in the 'trabeculæ'.

Five of these animals showed no certain deviations from the normal, and it must be presumed that the well-known capacity of the head neural crest in Amphibia to regulate after incomplete removal is shared by that of the lamprey. In the other ten animals there were marked deficiencies, unilateral or bilateral, in one or more of all the cranial ganglia (profundus, trigeminus, facialis, glossopharyngeus and vagus). The first spinal dorsal root ganglion was similarly affected in some cases. In contradistinction to the findings of Stone[3] in Amphibia, the deficiencies in the cranial ganglia were very marked, and in some instances involving the facialis and vagus there was almost complete absence of the ganglion on one side of the animal. The truncus epibranchialis of the vagus, which is generally thought to be of placodal origin, was not affected.

The visceral skeleton, which is represented in larvæ of this age by chondrified bars supporting only rudimentary hypo- and epitrematic elements, showed no deficiencies in any of the animals, even where the ganglion of the corresponding segment was almost completely lacking. Similarly, the 'trabeculæ' were in no case abnormal, even in the three animals which showed deficiencies in the profundus, and the one which had both a defective profundus and trigeminus.

It cannot be said that these results support Hatta's view of the mesodermal origin of the head skeleton. Not only is the material too limited for decision; but more particularly there are good reasons for believing that important sources of ectomesenchyme other than the neural crest exist in the lamprey[1]. They do, however, give confidence in the suitability of the experimental method for solving the problem. It is proposed to continue this work on a larger material, and on other sites of ectomesenchyme formation, during the next breeding season.

I am deeply indebted to Mr. A. R. Hockley, Dr. P. Ford and Mr. M. Aberorombie for help during the course of the investigation.

D. R. NEWTH

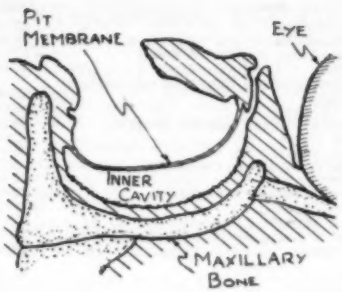
Department of Zoology
and Comparative Anatomy,
University College,
London, W.C.1.

[1] Landacre, F. L., *J. Comp. Neurol.*, **33**, 1 (1921).
[2] de Beer, G. R., *Proc. Roy. Soc.*, B, **134**, 377 (1947).
[3] Stone, L. S., *J. Exp. Zool.*, **35**, 421 (1922).
[4] Hörstadius, S., and Sellman, S., *Nova Acta Soc. Sci. Upsal.*, Ser. 4, **13** (1946).
[5] Dohrn, A., *Mitt. Zool. Sta. Neapel.*, **15**, 555 (1902).
[6] Goronowitsch, N., *Anat. Anz.*, **7**, 454 (1892).
[7] de Beer, G. R., *Quart. J. Micro. Sci.*, **74**, 701 (1931).
[8] Koltzoff, N. K., *Bull. Soc. Nat. Mosc.*, **15**, 259 (1901).
[9] Damas, H., *Arch. Biol.*, **55** (1944).
[10] Hatta, S., *Proc. Roy. Soc.*, B, **88**, 457 (1916).
[11] Johnels, A. G., *Acta Zool.*, **29**, 139 (1948).

Function and Operation of the Facial Pit of the Pit Vipers

Noble and Schmidt[1] have shown that the facial pit of the pit vipers (Crotalinæ) is a sensory organ enabling the snakes to detect warm-blooded animals in absolute darkness. Their work indicates that this organ senses the radiation from the warm-blooded animals.

The accompanying sketch of the pit from Dr. W. Gardner Lynn's report[2] shows so striking a similarity to a pneumatic radiant-energy detector[3] that one is led to believe that the pit operates in somewhat the same manner; namely, the inner cavity is heated by the radiation and the air in it expands, deflecting the pit membrane. The ultimate branches of the nerves



supplying the pit are distributed in the pit membrane and respond to this deflexion. This interior cavity communicates with the exterior through a small opening near the eye surrounded by a sphincter muscle, and this channel serves as a 'leak' tube in which the rate of flow can be controlled by the sphincter muscle.

Noble and Schmidt have shown that the pit can also sense gusts of air and the motion of cold objects. This can be explained by observing that the motion causes a motion of the air, which in turn can cause a deflexion of the membrane. It is also interesting to note that the surface of the interior cavity is very scalloped, thus making this surface a more efficient absorber of radiation. The membrane is guarded against damage from mechanical sources by being set in a recess (the pit) and is guarded against damage by strong radiation sources and warm environments by the ability of the sphincter muscle to open and close the 'leak' tube.

MYRON J. BLOCK

Engineer Research and
Development Laboratories,
Fort Belvoir, Virginia.
Aug. 3.

[1] Noble, G. K., and Schmidt, A., *Proc. Amer. Phil. Soc.*, **77**, 263 (1937).
[2] Lynn, W. Gardner, *Amer. J. Anat.*, **49**, No. 1 (1931).
[3] Golay, Marcel, J. E., *Rev. Sci. Instr.*, **18**, 357 (1947).

A Dispersion of Mosquitoes by Wind

ON the nights of July 28 and August 25, 1942, there were mass migrations of mosquitoes into the camps of the Eighth Army in the Western Desert of Egypt. They became abundant in all tents and vehicles over an area of not less than 75 square miles. They then became scarcer and disappeared after three or four days, when no further specimen could be found.

On July 29 an inspection of the eaves of tents showed some dozens of mosquitoes at rest in each tent, a large majority being *Anopheles pharoensis*. Of 14 specimens collected, 11 were females of this species and 3 were *Culex* sp. (2♂, 1♀). The *Anopheles*, which were in fresh condition, contained partly digested blood, having fed before daybreak on the men in camp. Most men had been awakened by the biting mosquitoes. On August 16 several cases of pyrexia were passed through the writer's Light Field Ambulance; but as the unit had no facilities for laboratory diagnosis it was not possible to say if they were malarious. Barber and Rice[1] showed that *A. pharoensis* is a natural vector in Egypt.

The nearest possible breeding place of these swarms was the swamp near Alexandria called Mallahet Maryut, beginning about 18–28 miles north-east of the area of known invasion. A tour of the camps in this area showed that the mosquitoes were abundant in them all, and doubtless they extended still farther to the south and west.

Both migrations occurred at full moon; indeed, at the time of the second there was an eclipse. A guard on night duty on July 28 said there were no mosquitoes in the early part of the night: they arrived between 2 and 3 a.m., "coming in a cloud of vapour from the north, which looked like a dust storm by moonlight". Strong north-east winds blew on both nights. I am certain that the swarms were wind-borne, since not even large troop movements (of which none was in evidence) could have accounted for the sudden arrival of millions of mosquitoes in the static camps.

The phenomenon supports an observation by Kirkpatrick[2] which has been discounted by later writers. He stated in 1925: "I have myself taken *Anopheles pharoensis* in the Eastern Desert of Egypt almost midway between Cairo and the Gulf of Suez, 35 miles from the Nile valley and some 45 miles from the nearest possible breeding places to the north-west in the direction of the prevalent wind".

It was after this that Sergent *et al.*[3] contested "the popular belief that mosquitoes are carried long distances by wind". Eyles[4], in a recent review of the dispersion habits of Anophelines, gives 5·6 miles as the longest known flight-range of *A. pharoensis*, referring to Kirkpatrick's paper only in general terms; and De Meillon[5], describing the bionomics of the Anophelini of Africa, does not mention flights of this order by *A. pharoensis* nor, I believe, by any other species. The longest flights mentioned by Eyles[4] for any *Anopheles* are 19 miles for a seasonal flight of *A. gigas* and 15·5 miles for *A. pulcherrimus*. Reference to Manson and Ramsay[6] shows that in the case of *A. gigas* the evidence was inconclusive.

Another interesting feature of the Egyptian migrations was their occurrence each time at full moon. Another record of mosquito migrations at full moon is given by Rees[7] for *Aedes dorsalis*, over a distance of two miles at Salt Lake City. As the Egyptian migrations occurred many weeks before the end of the dry summer, they can scarcely have been pre-hibernation flights of the kind studied by Kligler[8] in *Anopheles sacharovi*. In any event, none of the *A. pharoensis* appeared to contain a developed fat body. If they were not caught involuntarily in an air current (and the fact that the swarms were mixed may point to this explanation), they may be subject to a distinct type of biological dispersion depending on the lunar cycle.

Whatever the cause, is it not possible that one or more species has in the past reached such a place as the Siwa Oasis, where Barber and Rice[1] took *A. sergenti*, *A. multicolor* and *A. pharoensis*, on a wind which could travel two hundred miles across the desert in one night?

C. GARRETT-JONES

London School of
Hygiene and Tropical Medicine,
London, W.C.1.

[1] Barber, M. A., and Rice, J. B., *Amer. J. Trop. Med.*, **17**, 413 (1937).
[2] Kirkpatrick, T. W., "The Mosquitoes of Egypt" (Cairo, 1925).
[3] Sergent, E., *et. al.*, "Carte du Paludisme en Algérie" (Algiers, 1928).
[4] Eyles, D. E., U.S. Public Health Bull. No. 287 (1944).
[5] De Meillon, B., "The Anophelini of the Ethiopian Geographical Region" (Johannesburg, 1947).
[6] Manson, D., and Ramsay, G. C., *Rec. Mal. Surv. Ind.*, **3**, 479 (1933).
[7] Rees, D. M., *Mosquito News*, **5**, 134 (1945).
[8] Kligler, I. J., *Trans. Roy. Soc. Trop. Med.*, **26**, 73 (1932).

Œdema of the Bowel in Pigs

THIS obscure condition, which was first described by Shanks[1] and Lamont[2], has now become a major hazard to store-pigs in the whole of Ireland. It is now apparently causing serious concern in Great Britain. Repeated attempts at transmission by the staff at this laboratory have so far failed. A few months ago we came across a reference by Kurnick[3] to a condition in the human characterized by œdema which was thought to be due to a protein deficiency. In July 1949, Dr. Mitchell, Dominion Pathologist, Canada, visited this laboratory, and he directed our attention to the work carried out by Gwatkin and his associates[4] on the protein fraction in the diet of the pig.

We have carried out a series of serum protein estimations in the blood of the pig from litters in which deaths from gut œdema have been occurring. The estimations have been made by the biuret method using the Lovibond comparator.

Forty-four such blood samples have so far been examined, as well as a number of controls from litters with no history of gut œdema. Thirty-three control blood samples gave an average figure for serum protein of 6·64 gm. per cent. The highest figure was 8 gm. and the lowest was 5·5 gm. per cent. Forty-four samples of serum from 'in contact' and affected pigs ranged from 2·5 gm. per cent to 7·0 gm. per cent, with an average figure of 4·63 gm. per cent over all the samples.

It is emphasized that the vast majority of the latter group did not show any symptoms of the disease, even though the serum protein-level was much below the level of the control group. None of the sick pigs examined so far had a serum protein-level above 5 gm. per cent, though some of the 'in contact' apparently normal pigs in this group had also serum protein-levels of this low order. The preliminary work tends to show that, associated with this condition of gut œdema, there is a well-marked hypoproteinæmia.

The purpose of this note is to direct the attention of other research workers to this observation, which may prove significant in the etiology of this obscure condition.

The assistance given and the interest shown in this work by our technician, Mr. T. Cahil, is gratefully acknowledged.

D. LUKE
W. A. M. GORDON

Veterinary Research Division,
The Farm,
Stormont, Belfast.
Oct. 15.

[1] Shanks, P. L., *Vet. Record*, **50**, 356 (1938).
[2] Lamont, H. G., *Vet. Record*, **50**, 1377 (1938).
[3] Kurnick, N. B., *Ann. Int. Med.*, **28**, 782 (1948). Abstracted in *Nut. Abs.*, **18**, No. 2407.
[4] Gwatkin, R., Moynihan, I. W., and Bankier, J. C., *Can. J. Comp. Med.*, **6**, 5.

Geographical Distribution of the Body-Weight/Body-Surface Ratio

IN the course of biometrical work concerning twenty different human samples—the individual figures partly obtained by myself and partly taken from other sources—I have found the following values for the body-weight/body-surface ratio (kgm./m.²):

	Men	Average	σ
72	French workers	37·99	1·93
75	French soldiers	37·88	2·10
107	Italian soldiers (natives of Sicily)	37·43	1·86
37	Albanians	37·05	1·97
70	men from Southern Europe (Mediterranean countries)	36·93	1·75
21	Arabs (Yemen)	36·01	1·47
99	Annamites (French Colonial troops)	36·02	1·30
124	Somalis Darod	35·09	1·78
117	Somalis Rahanoween	34·67	1·73
87	Somalis Hawiyah (Haweeah)	34·42	1·54
47	Somalis Dir	34·42	1·77
50	Negroes Gobaween (Somalia)	34·71	1·67
107	Otomies (Mexico)	34·98	1·83
19	Berbers (Glado)	35·41	1·75
25	Daouad (Fezzan, North African desert)	33·92	1·20
40	Andamanese	32·42	1·71
	Women		
54	Parisians	35·83	2·68
34	Rahanoween	37·92	2·05
15	Gobaween	37·43	1·53
36	Andamanese	33·35	2·32

When we compare geographically distant groups, the differences are statistically significant. For example, if we compare the lowest European average (36·93) and the highest non-European average (36·02), we find that the ratio of difference to standard error of difference is 3·6; the same ratio is 5·0 if we compare French workers with Arabs, and 10·3 if we compare the same workers with Darod Somalis.

There is obviously a decline of the value of the ratio as we proceed from temperate to tropical regions. Of course, ratios do not follow exactly either latitudes or isotherms—such would be indeed surprising—but the general tendency is clear. Perhaps, even in Europe there is some decrease from north to south. The last of the 'Europoid' samples (Yemenite Arabs) is apparently outside the European range, the lower limit of which, for the adult male, seems to be approximately 37·00. The Arabs have practically the same ratio as the Annamites (natives of Tonkin, northern Indo-China, a country with a relatively fair tropical climate). The decrease is more evident if we compare European values with those of other samples from desert or tropical surroundings.

Now, the ratio weight/surface plays a part in the regulation of body-heat. In a hot climate a relative deficiency of body-mass—or relative excess of body-surface—is an advantage. Possibly climatic agencies operated selectively with a convergent result; but, if so, it would be a peculiar kind of convergency, with radically divergent anatomical implications, as the same biologically important ratio is attained by the extreme dolichomorphs (Somalis) and the extreme brachymorphs (Otomis).

If this be true, we must admit at the same time the interference of an independent sexual factor, for the position is not the same with women. Unfortunately, the latter are represented only by four samples (I lost during the War the data concerning Otomi women I measured in 1936). Nevertheless, there appears to be a racial as well as a sexual difference: the average ratio for French women is definitely lower than the ratio for any European male sample; the ratio for 'tropical' women is definitely higher than the ratio for men of the same stock. It must be remembered that, in women, heat regulation does not work in exactly the same way as in men.

A full account of these findings, together with a detailed anthropometrical body-build analysis, of eleven kinds of males and three kinds of females, will be published in *l'Anthropologie*.

EUGÈNE SCHREIDER
Laboratoire d'Anthropologie Physique,
1 rue René-Panhard, Paris, XIII.
Oct. 3.

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, February 18

INSTITUTION OF MECHANICAL ENGINEERS, GRADUATES' SECTION (at Storey's Gate, St. James's Park, London, S.W.1), at 3 p.m.—Sir Harry Ricardo, F.R.S.: "Combustion in Diesel Engines".

Monday, February 20

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Joint Staff Common Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Dr. M. D. H. Strauss: "Quantum Theory and Logic".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Prof. Max Born, F.R.S.: "Physics and Metaphysics" (Joule Memorial Lecture).*

UNIVERSITY OF LONDON (in the Anatomy Theatre, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. H. C. Darby: "Domesday Geography" (Inaugural Lecture).*

INSTITUTION OF ELECTRICAL ENGINEERS, LONDON STUDENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Prof. E. B. Moullin: Presidential Address.

INSTITUTION OF THE RUBBER INDUSTRY, LIVERPOOL SECTION (joint meeting with the LOCAL SECTION of the ROYAL INSTITUTE OF CHEMISTRY, at Common Hall, Hackins Hey, Liverpool), at 7 p.m.—Mr. P. G. Croft-White: "Petroleum Products for the Rubber Industry".

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 8 p.m.—Mr. J. M. Waldram: "Public Lighting" (Cantor Lectures). (Further Lectures on February 27 and March 6.)

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 8.15 p.m.—Mr. Peter Lloyd: "British Expedition to Nepal".

Tuesday, February 21

BRITISH PSYCHOLOGICAL SOCIETY, INDUSTRIAL SECTION (in Room 105, London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 1 p.m.—Dr. D. W. McElwain: "Researches in Social Psychology in the University of Melbourne".

ROYAL ANTHROPOLOGICAL INSTITUTE (at 21 Bedford Square, London, W.C.1), at 5 p.m.—Dr. J. D'A. Waechter: "Preliminary Excavations at Gorham's Cave, Gibraltar".

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Discussion on "Electrical Methods of pH Measurement" (to be opened by Mr. G. I. Hitchcox and Mr. G. R. Taylor).

UNIVERSITY OF LONDON (at King's College, Strand, London, W.C.2), at 5.30 p.m.—Prof. J. F. Danielli: "The Preservation of Science and Learning" (Inaugural Lecture).*

CHEMICAL SOCIETY, LEEDS SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Leeds), at 6.30 p.m.—Dr. H. D. Springall: "Some Recent Applications of Dipole-Moment Measurements to Molecular Structure".

INSTITUTE OF PETROLEUM, NORTHERN BRANCH (at the Engineers' Club, Albert Square, Manchester), at 6.30 p.m.—Symposium on "The Petroleum Industry as a Career".

Wednesday, February 22

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Mr. Kenneth Holmes: "The Linking of Technical and Art Education".

ROYAL METEOROLOGICAL SOCIETY (at 49 Cromwell Road, London, S.W.7), at 5 p.m.—Mr. J. E. N. Hooper and Mr. A. A. Kippax: "The Bright Band—a Phenomenon associated with Radar Echoes from Falling Rain", to be followed by a Discussion on "Radar Echoes".

ROYAL STATISTICAL SOCIETY (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 5.15 p.m.—Mr. P. G. Gray and Mr. T. Corlett: "Sampling for the Social Survey".

INSTITUTION OF ELECTRICAL ENGINEERS (joint meeting of the SUPPLY AND UTILIZATION SECTIONS, at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. L. Gosland: "The Cost and Efficacy of Earthing on Low- and Medium-Voltage Overhead-Line Systems".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY, CHEMICAL SECTION (at the Portico Library, Mosley Street, Manchester), at 5.45 p.m.—Dr. E. G. Edwards: "Some Aspects of Freedom for Science".

PLASTICS INSTITUTE, LONDON AND DISTRICT SECTION (at the Waldorf Hotel, Aldwych, London, W.C.2), at 6.30 p.m.—Mr. A. A. Tomkins: "Advances in Moulding Technique".

ROYAL STATISTICAL SOCIETY, BIRMINGHAM AND DISTRICT GROUP of the INDUSTRIAL APPLICATIONS SECTION (at the Chamber of Commerce, 95 New Street, Birmingham), at 6.30 p.m.—Mr. D. J. Desmond: "Specifications and Tolerances". (To be repeated at 6.30 p.m. at the Chemical Industries Club, 18 Lovain Place, Newcastle-upon-Tyne, on Wednesday, April 19.)

INSTITUTION OF THE RUBBER INDUSTRY, LEICESTER SECTION (at the Technical College, Leicester), at 7 p.m.—Mr. W. P. Fletcher: "Technical Aspects of High Polymers".

SOCIETY FOR VISITING SCIENTISTS (at 5 Old Burlington Street, London, W.1), at 7.30 p.m.—Discussion on "The Planning of Agricultural Research in Great Britain" (Speakers: Dr. W. K. Slater, Dr. C. D. Darlington, F.R.S., Prof. S. Zuckerman, F.R.S.).

Thursday, February 23

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Sir Arthur Fleming and others: "The Research Laboratories of Associated Electrical Industries, Limited".

UNIVERSITY OF LONDON (in the Physiology Theatre, University College, Gower Street, London, W.C.1), at 4.45 p.m.—Dr. Tudor S. G. Jones: "The Peptide Bond in Biochemistry".* (Further Lectures on March 2 and 9.)

LINNEAN SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Discussion on "Morphology and Fine Structure" (to be opened by Dr. C. F. A. Pantin, F.R.S., Dr. J. R. Baker, Dr. L. E. R. Picken and Mr. J. E. G. Bradfield).

CHEMICAL SOCIETY, NOTTINGHAM SECTION (joint meeting with the UNIVERSITY CHEMICAL SOCIETY, in the Chemistry Lecture Theatre, The University, Nottingham), at 6.30 p.m.—Prof. A. R. Todd, F.R.S.: "Synthesis in the Nucleotide Field".

ROYAL AERONAUTICAL SOCIETY, GRADUATE AND STUDENT SECTION (at 4 Hamilton Place, London, W.1), at 7.30 p.m.—Mr. W. R. Shapey and Mr. J. Rivers: "Some Problems of Heat Transfer".

UNIVERSITY OF LONDON (at Wye College, Wye, near Ashford, Kent), at 8.15 p.m.—Prof. G. W. Robinson, F.R.S.: "Soils and Crops".*

Friday, February 24

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the INSTITUTION OF ELECTRICAL ENGINEERS, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. J. F. Field: "The Application of Gas Turbine Technique to Steam Power".

NORTH-EAST COAST INSTITUTION OF ENGINEERS AND SHIPBUILDERS (at the Mining Institute, Neville Hall, Newcastle-upon-Tyne), at 6.15 p.m.—Mr. A. Emerson: "A Review of Ship Model Data".

OIL AND COLOUR CHEMISTS ASSOCIATION, MANCHESTER SECTION (in the Chemistry Lecture Theatre, The University, Oxford Road, Manchester), at 6.30 p.m.—Prof. M. G. Evans, F.R.S.: "The Design of Experiment". (All members of the Manchester Federation of Scientific Societies are invited.)

TELEVISION SOCIETY (at the Cinema Exhibitors' Association, 164 Shaftesbury Avenue, London, W.C.2), at 7 p.m.—Demonstration and Discussion on "Television Aids—Polaroid, Lenses, Filters, Lighting, Special Aerials, Interference Suppressors".

Saturday, February 25

BRITISH PSYCHOLOGICAL SOCIETY, EDUCATION SECTION (in the Hastings Hall, Tavistock House, Tavistock Square, London, W.C.1), at 2.30 p.m.—Mr. C. D. Butler: "The Development of Techniques for Testing Social Attitudes".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

HEAD OF THE DEPARTMENT OF PHYSIOLOGY, and a SENIOR ASSISTANT—The Clerk to the Governors, Chelsea Polytechnic, Manresa Road, London, S.W.3 (February 25).

LECTURER IN BIOLOGY—The Principal, Acton Technical College, High Street, Acton, London, W.3 (February 25).

LECTURER IN MATHEMATICS—The Clerk to the Governors, South-East Essex Technical College and School of Art, Longbridge Road, Dagenham (February 25).

LECTURER IN THE DEPARTMENT OF SCIENCE AND RELATED MATHEMATICS—The Principal, Aston Technical College, Whitehead Road, Birmingham 6 (February 25).

LECTURER IN HUMAN PHYSIOLOGY, and a LECTURER IN EXPERIMENTAL PHYSIOLOGY—The Registrar, The University, Manchester 13 (March 3).

CHAIR OF CHEMISTRY—The Principal, Heriot-Watt College, Edinburgh (March 6).

LECTURER IN THE DEPARTMENT OF CIVIL ENGINEERING—The Secretary and Registrar, The University, Bristol (March 6).

METALLURGISTS in a Ministry of Supply Research and Development Establishment in London, for work on refractories, electrodeposition and for analytical work—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.77/50A (March 7).

CHEMICAL ENGINEERS (Principal Scientific Officer and Senior Scientific Officer grades) at the Atomic Energy Research Establishment, Harwell, for duties in research groups dealing with pilot plant development of the wide range of chemical processes associated with the development of atomic energy and for fundamental research in the unit operations involved—The Secretary, Civil Service Commission, Scientific Branch, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2951 (March 7).

SENIOR SCIENTIFIC OFFICER and SENIOR EXPERIMENTAL OFFICER at a Ministry of Supply Establishment in South Wales, for laboratory work on development of methods of fabricating and testing special ceramic bodies and development of new apparatus for this purpose with responsibility for setting up a field station for routine production of specialized ceramics—The Secretary, Civil Service Commission, 7th Floor, Trinidad House, Old Burlington Street, London, W.1, quoting No. 2953 (March 7).

HONOURS GRADUATE IN PHYSICS or CHEMISTRY, for a research post in connexion with the Electrochemical Laboratory, for the study of electrode processes—The Registrar, King's College, Newcastle-upon-Tyne (March 11).

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (male) IN THE POMOLOGY SECTION, in connexion with the research programme on soil management in fruit plantations—The Secretary, East Malling Research Station, East Malling, Maidstone, Kent (March 17).

CHEMISTS (Scientific Officer class) (with good honours degree or equivalent in Chemistry) under the Ministry of Supply, in London: PHYSICAL CHEMIST for development work connected with use of novel materials for metallurgical work, a PHYSICAL and INORGANIC CHEMIST preferably with experience in quantitative estimation of radioactive materials, and a PHYSICAL CHEMIST with good grounding in modern physical methods and with bent for mathematical work—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting F.90/50A (March 18).

SCIENTIFIC OFFICERS (2) (Ref. F.92/50A) with good honours degree or equivalent in Chemical Engineering or Chemistry, with post-graduate academic training in chemical engineering, an INSTRUMENT ENGINEER (Experimental Officer class) (Ref. D.33/50A) with Higher National Certificate or equivalent in Electrical Engineering, with sound knowledge of Electronics, CHEMICAL ENGINEER (3, Experimental Officer class) (Ref. 92/50A) with Higher National Certificate or equivalent in Chemistry, with experience in preparative work employing technical or large-scale equipment, an ORGANIC CHEMIST (Experimental Officer class) (Ref. F.91/50A) with Higher National Certificate or equivalent in Chemistry, with ability to carry out organic preparative work, at a Ministry of Supply Research and Development Establishment in Lancashire—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting the appropriate Ref. No. (March 18).

PHYSICISTS (Scientific Officer grade) at a Ministry of Supply Research and Development Establishment near London: (*a*) ELECTRONIC PHYSICIST for work on application of electronic methods to photography of detonation phenomena, (*b*) CLASSICAL PHYSICIST for study of experimental results of work on detonation waves, (*c*) THEORETICAL PHYSICIST for work on effect of blast on structures, (*d*) PHYSICIST with wide and varied experimental experience, (*e*) GENERAL PHYSICIST with maths., for experimental work on electrical and optical investigations and mathematical analysis of results, (*f*) PHYSICIST with mathematical ability for work on aerials, (*g*) PHYSICIST and ELECTRONIC ENGINEER for work on electro-optical systems, (*h*) PHYSICIST with maths., to plan and organise experimental work with small team—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting A.21/50A (March 18).

READERSHIP IN PHARMACOLOGY at King's College, London—The Academic Registrar, University of London, Senate House, London, W.C.1 (March 24).

JOHN WILLIAM HUGHES CHAIR OF CIVIL ENGINEERING—The Registrar, The University, Liverpool (March 25).

CHAIR OF METALLURGY in the New South Wales University of Technology—The Agent-General for New South Wales, 56 Strand, London, W.C.2 (April 1).

GRADUATE IN THE PLANT PATHOLOGY DEPARTMENT, for work on fungus diseases of field crops—The Secretary, Rothamsted Experimental Station, Harpenden, Herts (April 17).

COLONIAL LIAISON OFFICER (preferably with an honours degree in Science, and should have had experience of biological research, preferably overseas) at the Pest Infestation Laboratory, Slough—The Technical and Scientific Register (K), York House, Kingsway, London, W.C.2, quoting G.25/50A (April 29).

SUSAN STEBBING STUDENTSHIP for post-graduate work in Philosophy—The Principal, Bedford College for Women, Regent's Park, London, N.W.1 (May 1).

NUFFIELD RESEARCH STUDENTSHIPS AND FELLOWSHIPS for experimental and theoretical research in Nuclear Physics—The Professor of Natural Philosophy, The University, Glasgow, W.2 (May 1).

ASSISTANT DUST SUPPRESSION OFFICER—The Divisional Establishment Officer, National Coal Board, North-Western Division, 47 Peter Street, Manchester 2.

ASSISTANT MANAGER (Shift Control) to be responsible for implementing policy and co-ordinating activities during closed hours in a large chemical factory in the Division of Atomic Energy (Production), Windscale Works, Sellafield (candidates must have an honours degree in Chemistry or Engineering, or associateship of the R.I.C., or corporate membership of I.M.E., I.E.E., or I.C.E.)—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

ASSISTANT WORKS MANAGER (with an honours degree in Chemistry or associateship of the R.I.C. or equivalent qualification, with several years' experience of chemical plant operation in industrial processes involving toxic hazards) to be responsible to the Works Manager for the operation of the plant in a large chemical factory—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

DIRECTOR OF PRODUCTION (with an honours degree in Chemistry, Physics or Engineering, long experience in the management of heavy chemical or similar production plants, and must understand modern methods of control by cost and technical figures, the safe operation of processes handling toxic materials, etc.)—The Administrative Branch, Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs.

GRADUATE LECTURER IN BIOLOGY—The Principal, North Staffordshire Technical College, Stoke-on-Trent.

HEAD OF THE MATHEMATICS DEPARTMENT—The Registrar, Technical College, Sunderland.

LECTURER IN PURE AND APPLIED PHYSICS—The Registrar, College of Technology and Commerce, The Newarke, Leicester.

ORGANIC CHEMIST with some research experience, and a PHYSICAL CHEMIST with some research experience—The Secretary, British Rayon Research Association, Barton Dock Road, Urmston, Manchester.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Great Britain and Ireland

Overseas Food Corporation. First Report of the Scientific Department, Crop Season 1947–1948. Pp. 56. (London: Overseas Food Corporation, 1949.) [712

Ministry of Fuel and Power. Reports of H.M. Inspectors of Mines for the Year 1947. Northern Division. Report by R. J. Edwards. Pp. 68. (London: H.M. Stationery Office, 1949.) 1*s.* 3*d.* net. [712

Department of Scientific and Industrial Research: Road Research Laboratory. Road Note No. 8: Some cases of Frost Damage to Roads. By D. Croney. Pp. 14+8 plates. (London: H.M. Stationery Office, 1949.) 9*d.* net. [712

The English Civic Universities. A Paper read to Teaching Officers of Overseas Universities at Cambridge in August 1949. By Sir Raymond Priestley. Pp. 24. (Birmingham: The University, 1949.) [812

Ministry of Fuel and Power. Report of H.M. Chief Inspector of Mines for the Year 1947. Pp. 58. (London: H.M. Stationery Office, 1949.) 1*s.* 3*d.* net. [812

British Medical Association and National Veterinary Medical Association. The Provision of Safe Milk of High Quality. Pp. 8. (London: British Medical Association, 1949.) [812

Index to Horticultural Abstracts. Vols. 11–15, 1941–1945. Compiled by D. Akenhead. Pp. iii+184. (Aberystwyth: Commonwealth Agricultural Bureaux, 1949.) 35*s.* [812

How to Befriend Laboratory Animals. By Charles W. Hume. Pp. 16. (London: Universities Federation for Animal Welfare, 1949.) 3*d.* [812

Ministry of Labour and National Service: Technical and Scientific Register. Present and Future Supply and Demand for Persons with Professional Qualifications. In Architecture. Pp. 20. 6*d.* net. In Chemistry. Pp. 24. 6*d.* net. In Electrical Engineering. Pp. 24. 6*d.* net. In Geology. Pp. 16. 4*d.* net. In Physics. Pp. 32. 6*d.* net. (London: H.M. Stationery Office, 1949.) [1212

British Welding Research Association. Annual Report 1948–49. Pp. 50. (London: British Welding Research Association, 1949.) [1212

African Abstracts: a Quarterly Review of Ethnographic, Social and Linguistic Studies appearing in Current Periodicals. (Published by the International African Institute with the Assistance of Unesco.) Vol. 1, No. 1, January 1950. Abstracts 1–163. Pp. 48. (London: Oxford University Press, 1950.) 6*s.* 6*d.*; annual subscription, 26*s.* [1212

Other Countries

First Annual Report of the Research Department of the Indian Coffee Board, 1947–48. Pp. 38. (Balehonnur: Indian Coffee Board, 1949.) 1 rupee. [512

Deutsche Akademie der Wissenschaften zu Berlin. Vorträge und Schriften, Heft 30: Die Ausgestaltung der Organismen; ein chemisches Problem. Von Kurt Noack. Pp. 38. 2.50 D. marks. Vorträge und Schriften, Heft 35: Wirkungsquantum und Naturbeschreibung. Von Prof. Dr. F. Hund. Pp. 18. 2.50 D. marks. (Berlin: Akademie-Verlag, 1949.) [512

Sitzungsberichte der Deutschen Akademie der Wissenschaften zu Berlin. Mathematisch-naturwissenschaftliche Klasse, Jahrgang 1948, Nr. 8: Über Wanderung des DDT im Insektennerven. Von Prof. Dr. Wolfgang Heubner. Pp. 8. (Berlin: Akademie-Verlag, 1949.) 1 D. mark. [512

United States Department of Agriculture. Circular No. 818: Use of the Parasite *Trichogramma minutum* for Controlling Pecan Insects. By Herbert Spencer, Luther Brown and Arthur M. Phillips. Pp. 17. (Washington, D.C.: Government Printing Office, 1949.) 10 cents. [712

Cawthron Institute. Annual Report, 1948–9. Pp. 50. (Nelson, New Zealand: Cawthron Institute, 1949.) [712

United States Department of the Interior: Geological Survey. Water-Supply Paper 1066: Floods of August 1940 in the Southeastern States. Pp. xi+554+22 plates. 2.75 dollars. Water-Supply Paper 1073: Water Levels and Artesian Pressure in Observation Wells in the United States in 1946. Part 3, North-Central States. Pp. vi+366. 1 dollar. (Washington, D.C.: Government Printing Office, 1949.) [712

New Zealand. Twenty-third Annual Report of the Department of Scientific and Industrial Research. Pp. 88. (Wellington: Government Printer, 1949.) 1*s.* 9*d.* [812

Bulletin of the American Museum of Natural History. Vol. 94, Article 5: A Revision of the Geometrid Moths formerly assigned to *Drepanulatrix* (Lepidoptera). By Frederick H. Rindge. Pp. 231–294. (Washington, D.C.: Government Printing Office, 1949.) 75 cents. [812

Annals of the New York Academy of Sciences. Vol. 52, Art. 3: Vitamin E. By K. E. Mason and 116 other authors. Pp. 63–424. 4.50 dollars. Vol. 52, Art. 4: Coccidosis. By S. Blackett and 42 other authors. Pp. 429–624. 3 dollars. (New York: New York Academy of Sciences, 1949.) [1212

Sugar Research Foundation. Technological Report Series, No. 6: Sugar Derivatives, a Survey of Potential Production Costs. By Harold E. Bode. Pp. xi+35. (New York: Sugar Research Foundation, Inc., 1949.) Free. [1212

Transactions of the American Philosophical Society. New Series, Vol. 39, Part 2: Artists in the Life of Charleston; through Colony and State from Restoration to Reconstruction. By Anna Wells Rutledge. Pp. 99–260. (Philadelphia: American Philosophical Society, 1949.) 2.50 dollars. [1212

Publications de l'Institut National pour l'Étude agronomique du Congo Belge. Rapport annuel pour l'exercice 1948. Hors série 1948. Pp. 290. (Bruxelles: Institut National pour l'Étude agronomique du Congo Belge, 1949.) 150 francs. [1212

Imperial College of Tropical Agriculture: Low Temperature Research Station. Memoir No. 23: Studies in Tropical Fruits, 17. The Respiration of Bananas in Different Concentrations of Oxygen at 53° F. and during subsequent Ripening in Air at 68° F. By E. E. Leonard. Pp. 33. (Trinidad: Imperial College of Tropical Agriculture, 1949.) [1212

Science in South Africa. Pp. 176. (Pretoria: Council for Scientific and Industrial Research, 1949.) 10*s.* [1212

United States Department of the Interior: Geological Survey. Water-Supply Paper 1028: Water Levels and Artesian Pressure in Observation Wells in the United States in 1945. Part 6, Southwestern States and Territory of Hawaii. Pp. vi+301. 75 cents. Water-Supply Paper 1053: Surface Water Supply of the United States, 1946. Part 5, Ohio River Basin. Pp. xiii+691. 1.75 dollars. (Washington, D.C.: Government Printing Office, 1949.) [1212

United States Department of Agriculture. Technical Bulletin No. 994: Biology of the Raisin Moth. By Heber C. Donohoe, Peres Simmons, Dwight F. Barnes, George H. Kaloostian, Charles K. Fisher and Carl Heinrich. Pp. 23. (Washington, D.C.: Government Printing Office, 1949.) 10 cents. [1212

Yale University School of Medicine. Ninth Annual Report of the Historical Library. Pp. 36. (New Haven, Conn.: Yale University School of Medicine, 1949.) [1212